Global Ring Network for Advanced Applications Development (GLORIAD)

ONT2 Workshop
September 13, 2005

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Animation by Korea Institute of Science and Technical Information

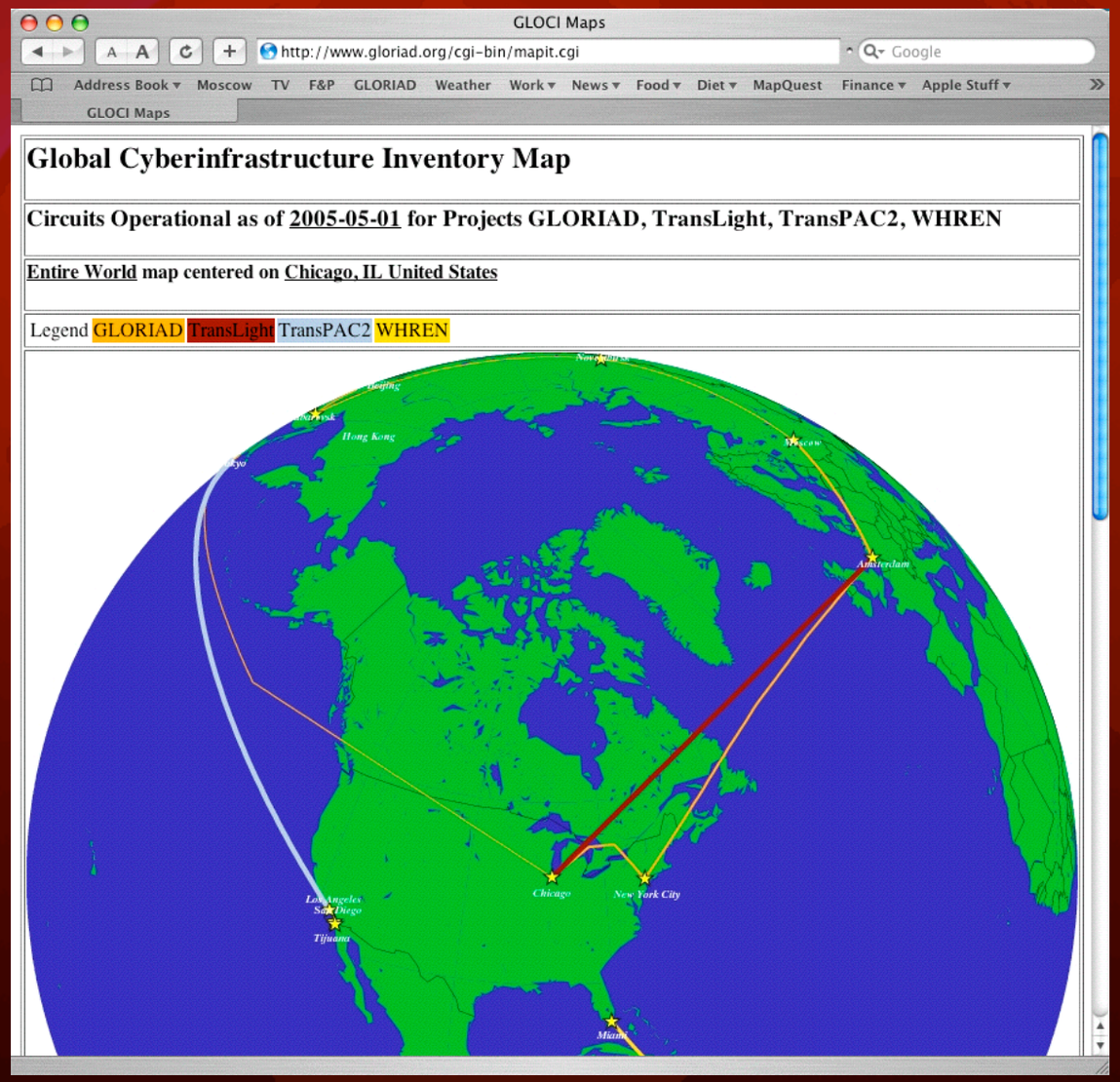
NSF IRNC Cooperative Agreement
University of Tennessee
$4.2M/5 years, began January 1, 2005

http://www.gloriad.org/

VSNL

NSF International Research Network Connections Program (IRNC)

- 5 yr $25M program to help advance international R&E network connections
- January 1, 2005 - December 31, 2009
  - GLORIAD - US-Russia-China-Korea-Netherlands-Canada
  - TransLight/Europe - US-Europe
  - TransLight/PacificWave - connections for Asia/Pacific
  - TransPAC2 - US-Japan/Asia
  - WHREN-LILA - US-Latin America
- Follow-on to NSF HPIIS Program (1998-2004) (Cumulative Funding from NSF for GLORIAD team: $9.5M)



GLORIAD

- An advanced S&E network “ring” around the northern hemisphere linking scholars, scientists, educators in Russia, US, China, Korea, Netherlands, Canada and others with specialized network services, co-funded by all international partners
- 155/622 Mbps today + 10G HK - KR - SEA, 10 Gbps ring in early 2007, N$_x$10G in 2008
- Hybrid circuit-(L1/L2) and packet-switched service (L3)
- Program to Develop/Deploy Advanced Cyberinfrastructure between partnering countries (and others) as effort to expand science, education and cultural cooperation and exchange
- A participant in/contributor to GLIF

Follow-on to NSF-/Russian MinSci-Funded MIRnet and NaukaNet programs ($5.5M, 1998-2004)

Why?

- Leverage jointly developed/funded/operated S&E network to expand S&E cooperation between partnering countries
- To support specific S&E applications not supported well by commodity or traditional R&E networks
- To enable communities to build their own specialized networks and for short durations of time
- To provide a test-bed for advanced network research
- To encourage compatible/complementary infrastructure development in closer step

Special Applications

- Need to move a terabyte of data quickly
- Need guaranteed 1.5 Gbps for high-definition uncompressed video for two hour session
- Need carefully managed/controlled “jitter” for steering a visualization (such as a “fly-through” application)
- Need a privately managed, secure network linking partners distributed around the globe
- Need to tie together large-scale computing resources with dedicated network services

Why?

Rita Colwell, former NSF Director, Dec. 2003 press release

"As part of the international community of science, we share common concerns that reach across national borders. As we all aim to strengthen our nations' capabilities in research, we also aim to contribute to the cumulative knowledge that lifts the prospects of people everywhere.

This new network serves as both a physical and symbolic reminder of our common goal of solving problems and building a world of peace and prosperity."

Dec. 21, 2003, NSF Press Release

GLORIAD History

- Early beginnings in 1994 with F&P, 1997 with CIVnet, 1999 with MIRnet, 2001 with NaukaNet
- Beijing agreement signed by Velikhov, Jiang, Cole in December 2002 to develop “Little GLORIAD”
- Little GLORIAD became operational on January 9, 2004 (Tyco OC3 links Chicago-Moscow, Chicago-Beijing); launched in Beijing January 12, 2004
- Moscow-Beijing OC3 (across Russia-China border) became operational in July, 2004. Ring complete.
- Proposal submitted to NSF IRNC program June, 2004
- Meeting hosted by Netherlands partners in September, 2004 – US, Russian, Chinese, Korean, European partners attend
- First meeting with Canadian partners in Nov, 2004
- HKLight launched by CAS/CNIC November 23, 2004
- NSF Grant funded December 2004, “Big GLORIAD” program begins in US on January 1, 2005
- 10G Hong Kong-Daejon-Seattle Circuit funded/ completed by Korean partners

GLORIAD TODAY

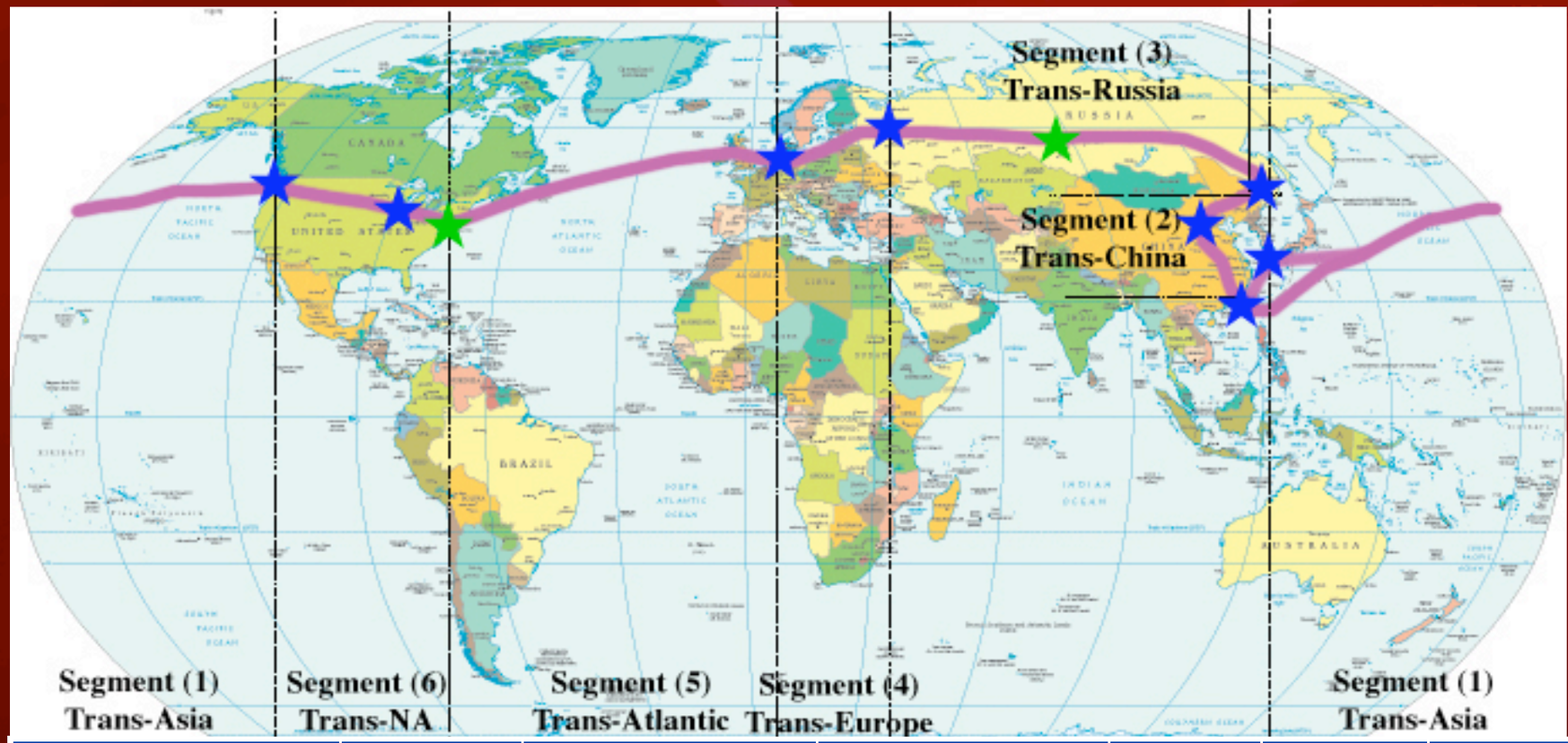
- GLORIAD Circuits Today
  - 622 Mbps Moscow-AMS-NYC
  - 1 GbE NYC-Chicago (CANARIE)
  - 155 Mbps Chicago-China Hong Kong
  - 2.5 Gbps China Hong Kong-Beijing
  - 2.5 Gbps AMS-Moscow
  - 155 Mbps Beijing-Khabarovsk-Moscow
  - 10 Gbps China Hong Kong-Daejon-Seattle
  - 10 Gbps Seattle-Chicago-NYC (via CANARIE contribution to GLORIAD/ GLIF)
- This year: 2.5 Gbps US-China link in October, 2005, 10 Gbps US-AMS in January, 2006

Grand Opening of “Big GLORIAD” September 5-6, 2005, Seoul, Korea

- KISTI (GLORIAD-KR) organized opening of first 10Gbps GLORIAD circuits – China HK - Daejeon Korea - Seattle
- Funded by Korean Ministry of Science (MOST)
- Project Leadership by KISTI, YoungHwa Cho, Jysoo Lee, Ok-Hwan Byeon
- Not only 60x capacity of original “Little GLORIAD” circuits but first “hybrid” network portion of GLORIAD
- New six-party agreement signed: US, Russia, China, Korea, Netherlands, Canada
- KISTI Unveiled first GLORIAD movie

The GLORIAD Network Topology

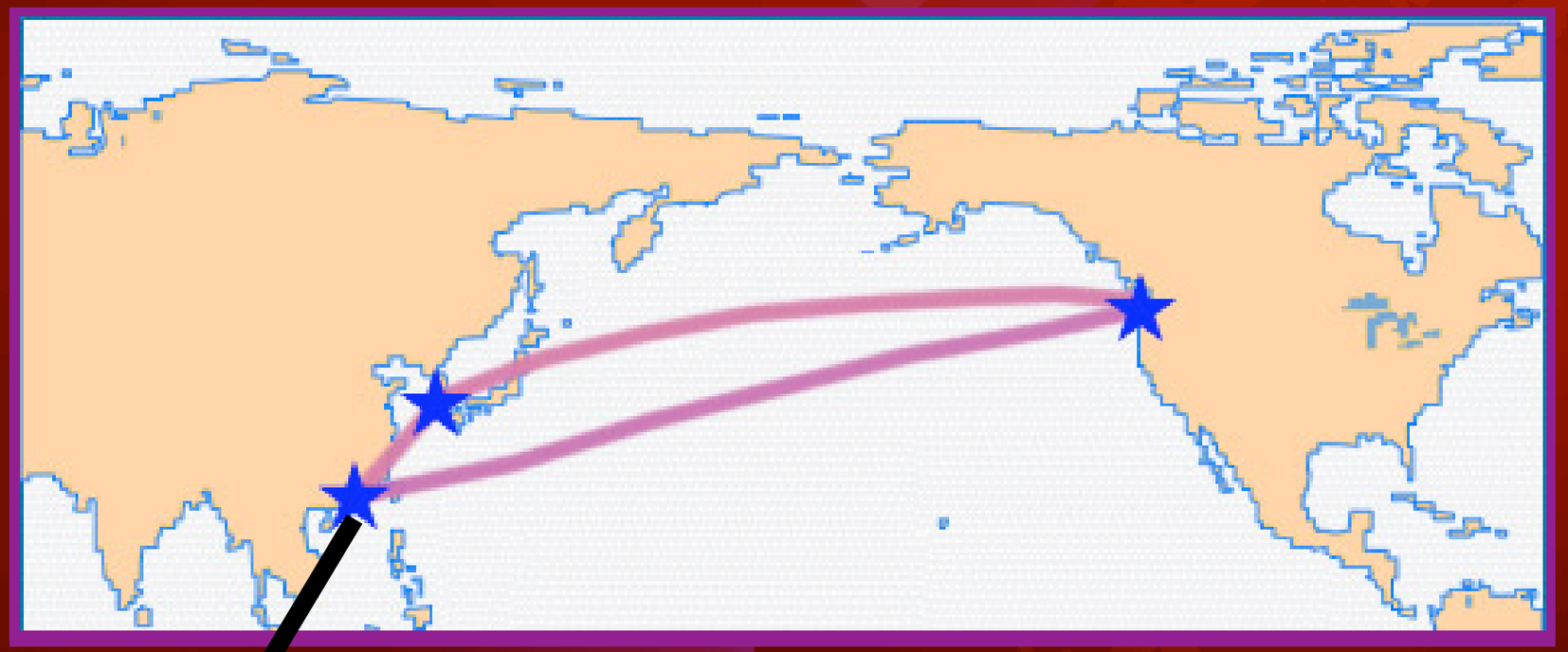
Current, Years 1-5



Segment	Current	Year 1	Year 2	Year 3	Year 4	Year 5
1 - Trans-Asia	155 Mbps	2.5 Gbps (US-China), 10 Gbps (US-Korea-China)	2 x 10 Gbps (US-China, US-Korea-China)	2 x 10 Gbps	N x 10 Gbps	N x 10 Gbps
2 - Trans-China	2.5 Gbps (155 Mbps, Beijing-Khabarovsk)	2.5 Gbps	1 x 10 Gbps	2 x 10 Gbps	N x 10 Gbps	N x 10 Gbps
3 - Trans-Russia	155 Mbps	155 Mbps	622 Mbps	1 x 10 Gbps	N x 10 Gbps	N x 10 Gbps
4 - Trans-Europe	622 Mbps	622 Mbps	622 Mbps	2 x 10 Gbps	N x 10 Gbps	N x 10 Gbps
5 - Trans-Atlantic	622 Mbps	1 Gbps	1 x 10 Gbps	2 x 10 Gbps	N x 10 Gbps	N x 10 Gbps
6 - Trans-North America	155 Mbps (Asia-Chicago), GbE NYC-Chicago (via CANARIE)	10 Gbps, Seattle-Chicago-NYC	10 Gbps, Seattle-Chicago-NYC	2 x 10 Gbps	N x 10 Gbps	N x 10 Gbps

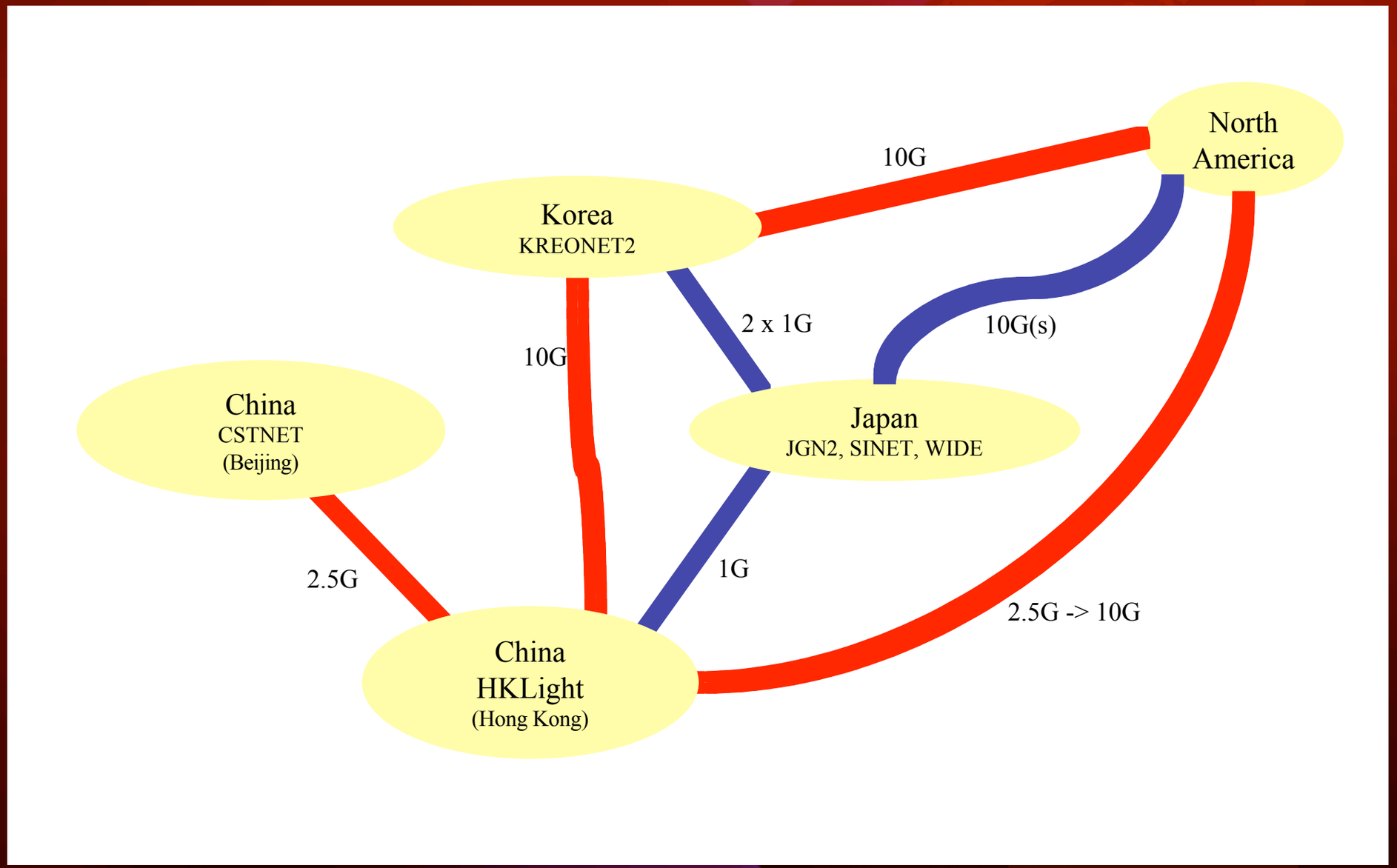
Trans-Pacific Portion (Segment 1)

(illustrating Hong-Kong–Seattle and Hong-Kong–Pusan–Seattle paths)



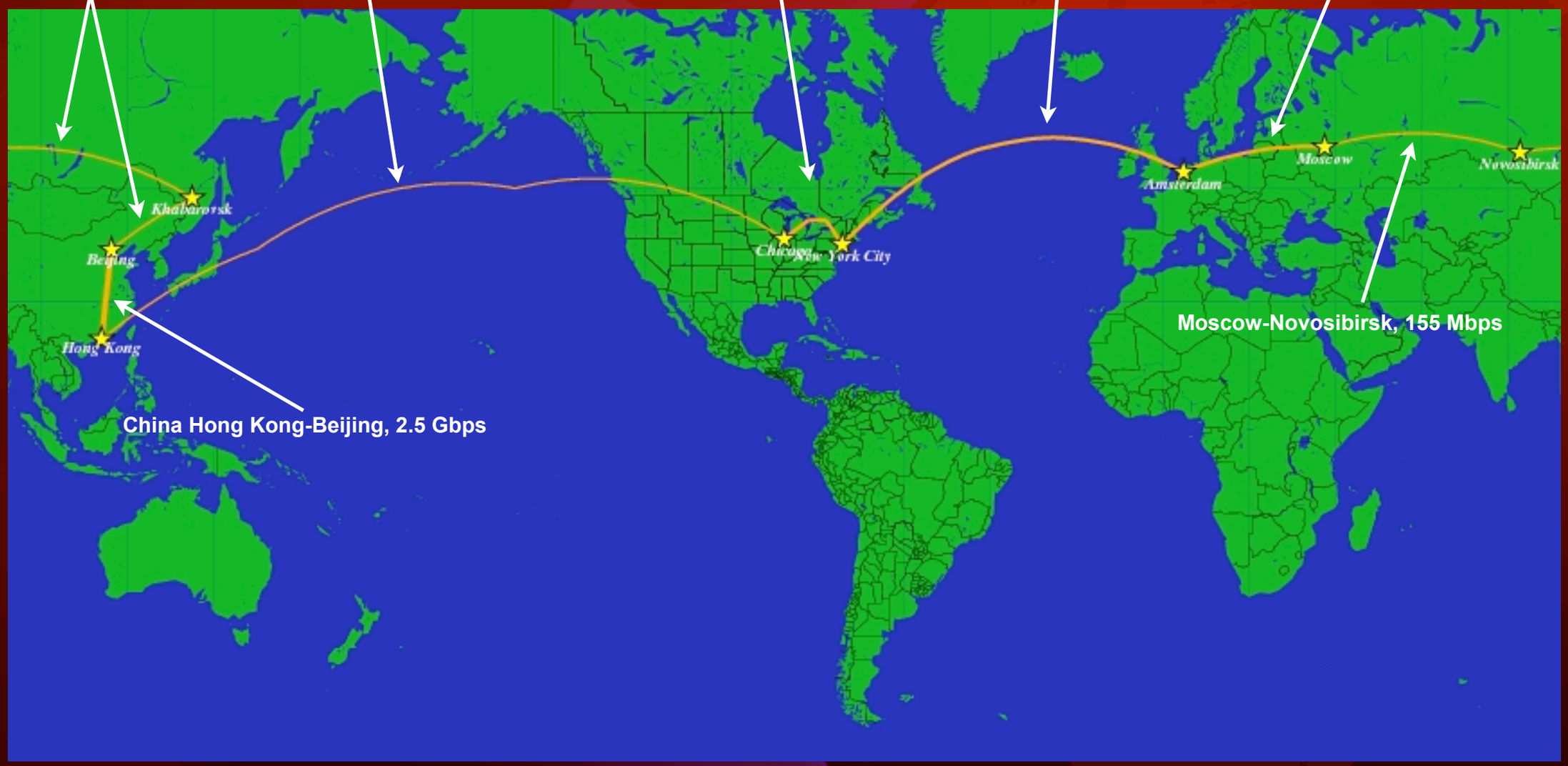
Hong Kong Light (HKLight) Open Exchange Point
Other exchange points include Starlight (Chicago), Pacific Wave (Seattle), Netherlight (Amsterdam), RussiaLight (Moscow)

China-Korea Links for North Asia



GLORIAD Network

On 6/7/2005



GLORIAD Network

Date: 8/16/2005

GLORIAD Network

Date: 3/1/2006

GLORIAD Network

Date: 3/1/2007

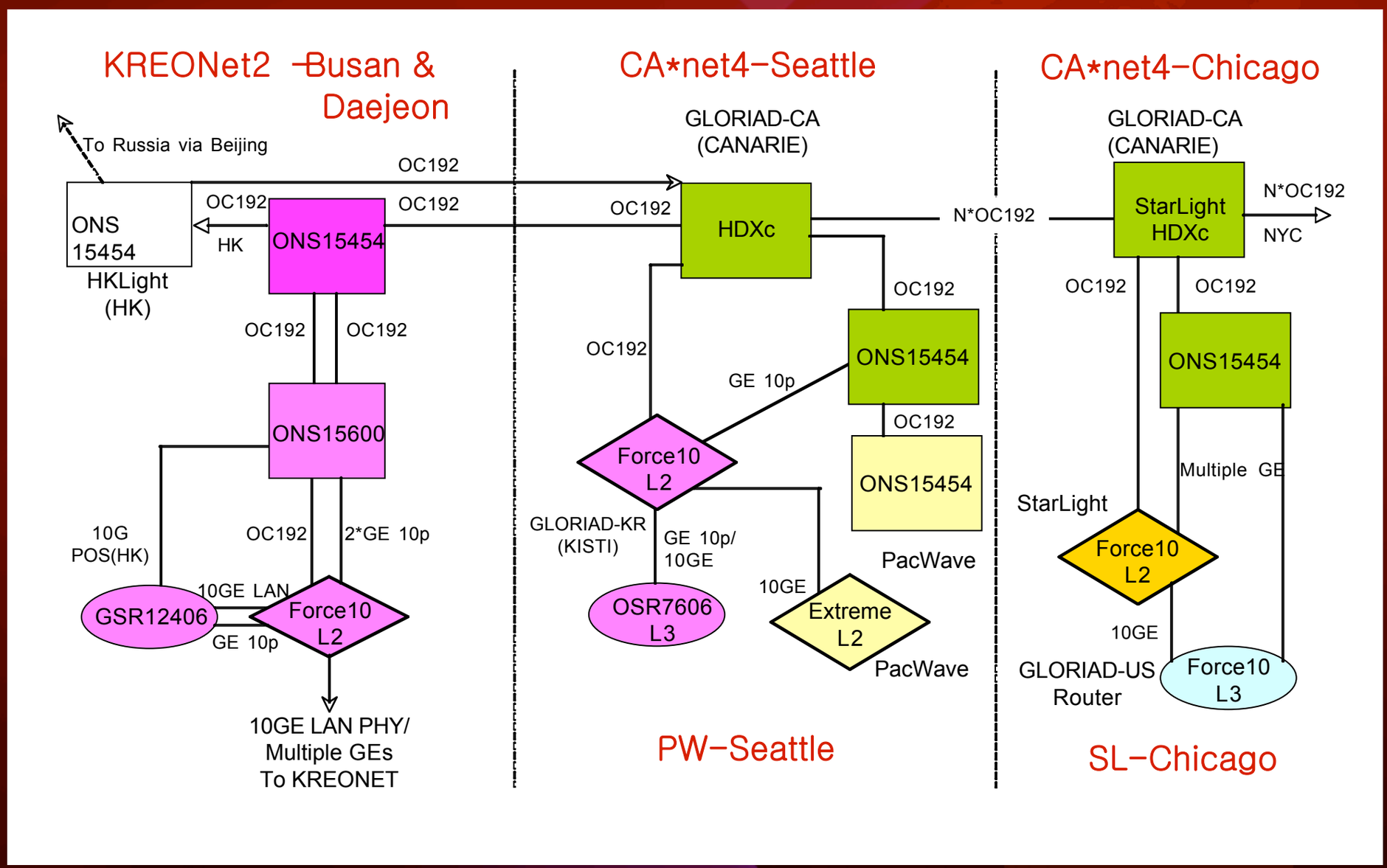
Architecture Motivation

- General S&E Applications – needs met by “best effort” routed infrastructure (but minimize congestion/packet loss)
- Specialized Applications requiring high capacity, low-latency and/or controlled jitter (i.e., dedicated end-to-end circuits)
- Network research/experimentation testbed
- Backup/protection services for partnering S&E networks

Network Design

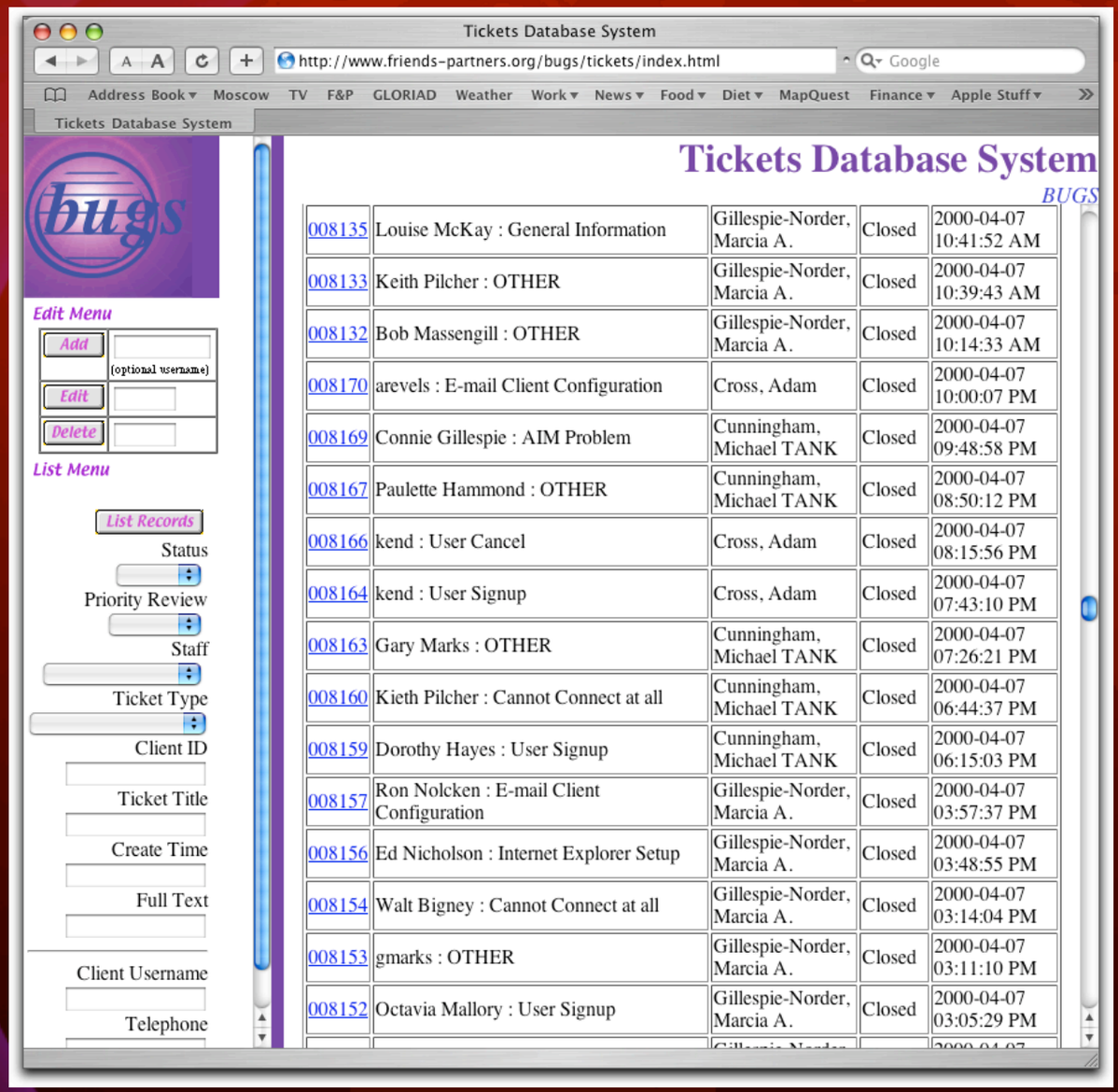
- Using MSPP devices (i.e., Ciena CoreDirector, Cisco ONS 15454, Nortel HDX, etc.), provide L1 infrastructure
- Instrument with UCLP to enable user community (and applications) to dynamically provision their own circuits across the core (and end-to-end where possible)
- Use N x GbE for layer-3 routed infrastructure (GLORIAD is in process of receiving its own AS number)
- Take advantage of ring topology for network reliability and for network experimentation
- Big emphasis on monitoring: (1) utilization, (2) performance, (3) security

10G Connectivity for Asian part of GLORIAD



Network Operations

- Developing “distributed NOC”
- Deploying own trouble ticketing system (integrated with monitoring sub-systems)



Working Groups / Governance

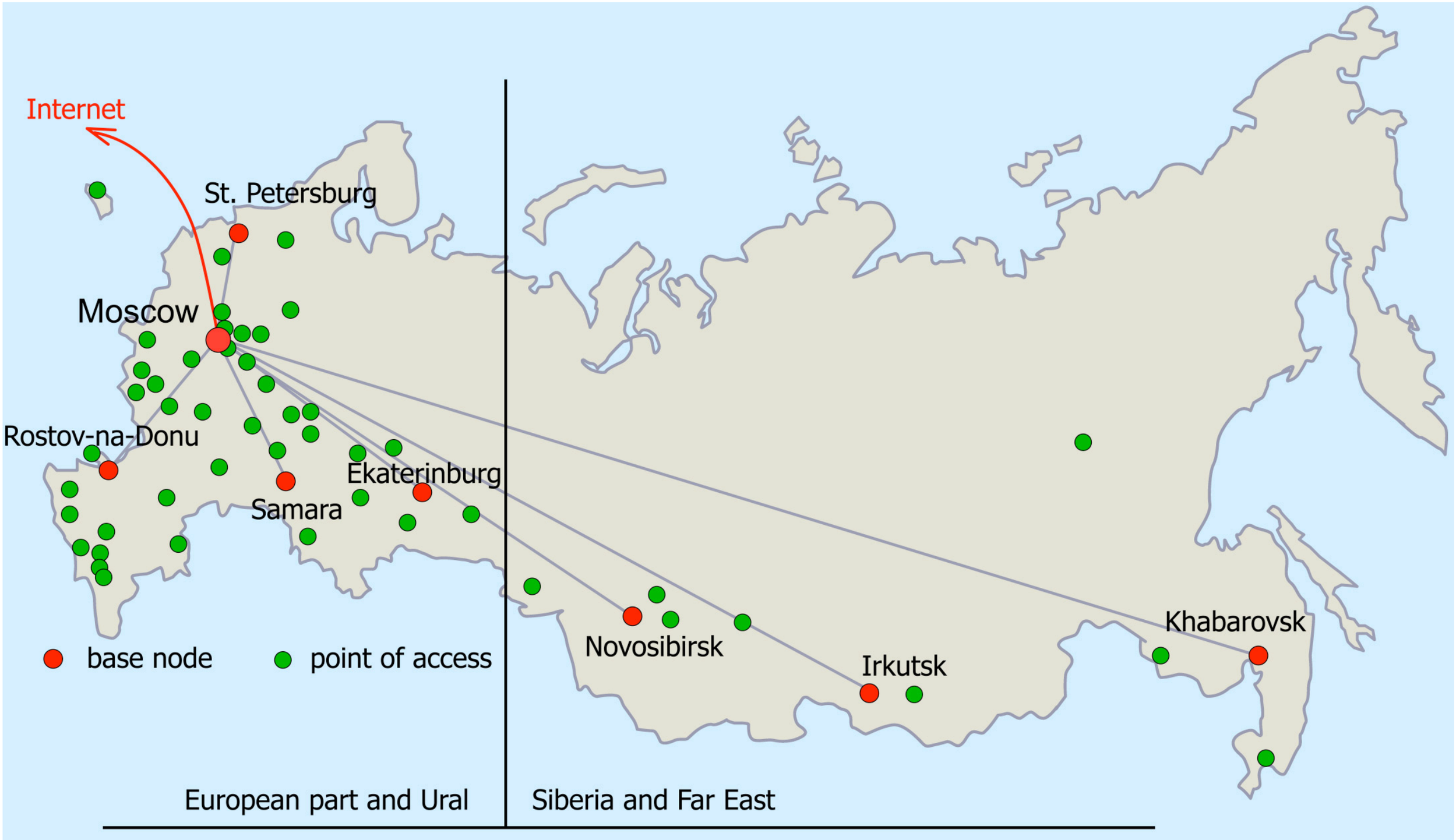
- Executive Board
- 30+ Working Groups Dealing with:
  - Networking Issues
  - Monitoring/Security Issues
  - Research Disciplines
  - Project Management
  - Education/Outreach Programs

Who in Russia?

- Acad. Evgeny Velikhov, President, Kurchatov Institute, Academician-Secretary, Russian Academy of Sciences
- Ministry of Science & Education, Agency of Communications, Agency of Atomic Energy, Moscow State University, Joint Supercomputing Center
- Russian Backbone Network (RBNet)

RBNet links

(General scheme)

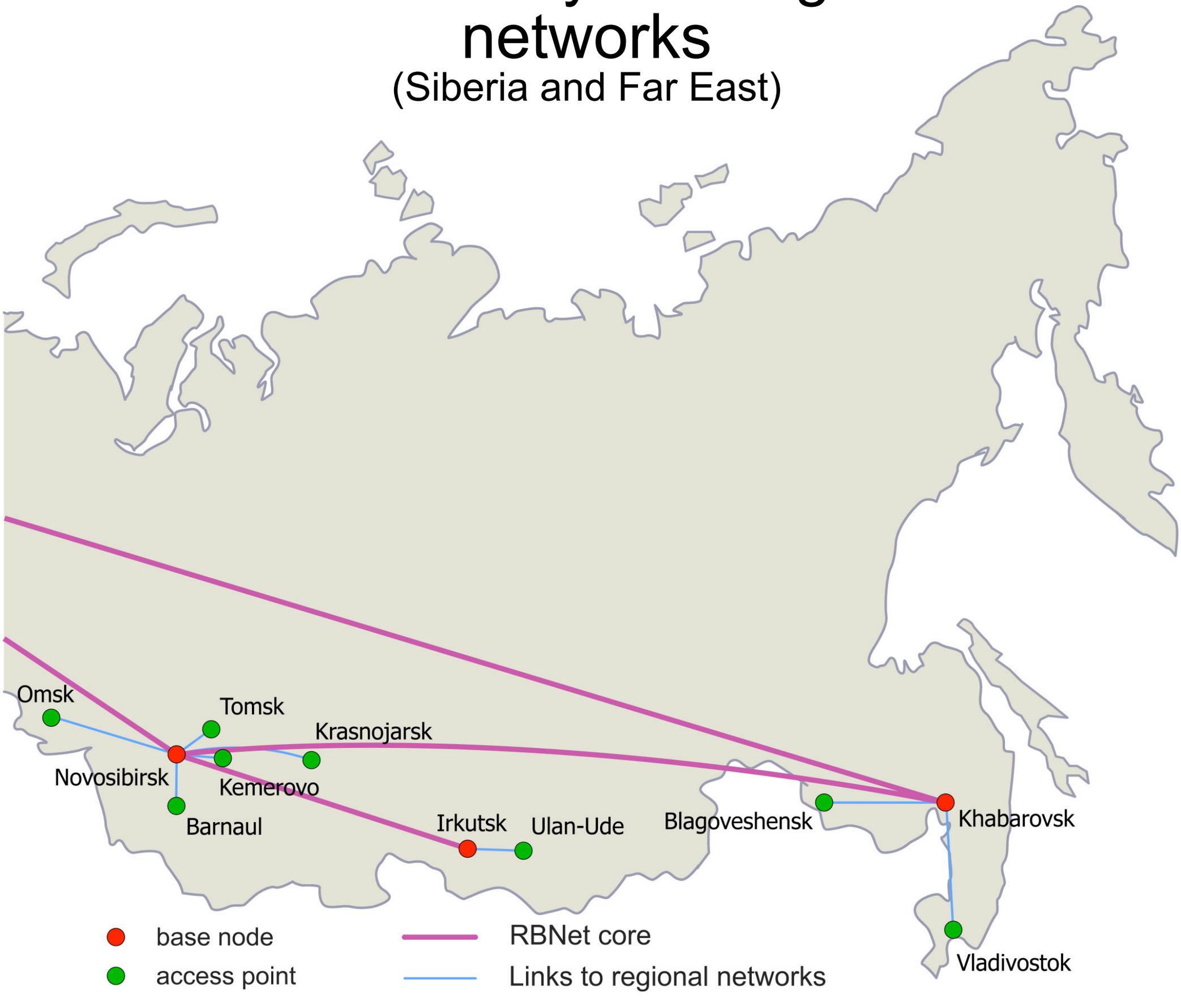


RBNet connectivity with regional R&E networks

(European part and Ural)

RBNet connectivity with regional R&E networks

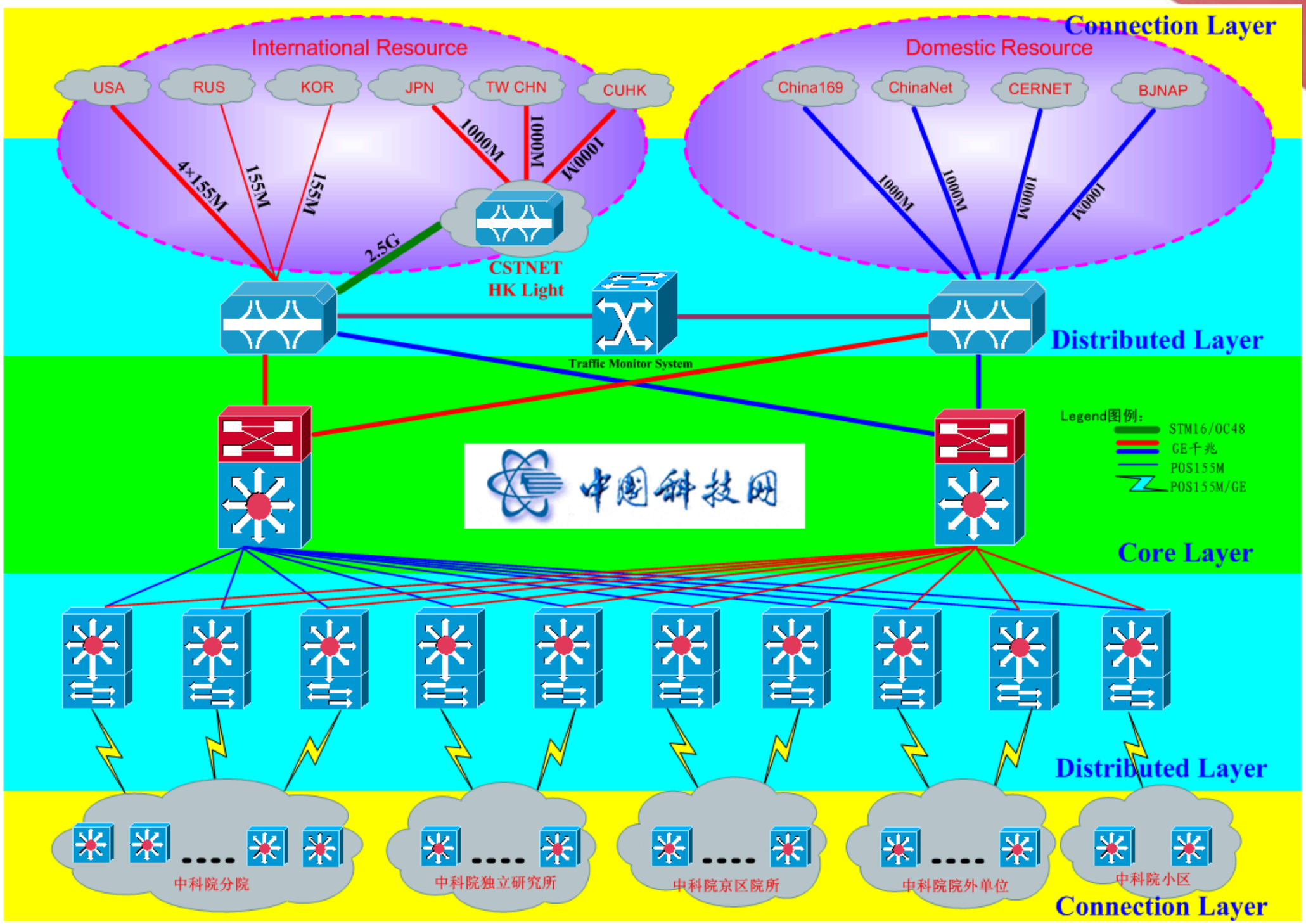
(Siberia and Far East)



Who in China?

- Dr. Mianheng Jiang, Vice President, Chinese Academy of Sciences, Telecomm/IT Developer (signatory of first GLORIAD agreement)
- Dr. Baoping Yan, Director, Computer Network Information Center (CNIC), Chinese Academy of Sciences. Directs all GLORIAD activities in China
- Dr. Jun Li, Deputy Director, CNIC, Director, China Science & Technology Network (CSTnet)

CSTNET Core Infrastructure



China Hong Kong Internet Open Exchange Point

- Nov 23, 2004, the Beijing-China Hong Kong section of the "China-US-Russia Global Ring Network for Advanced Applications Development (GLORIAD)" has been upgraded to 2.5G

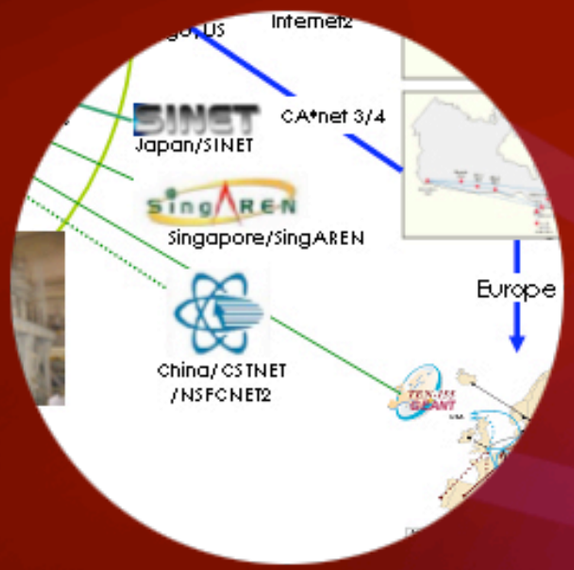
- On the same day, the Chinese Academy of Sciences formally announced a plan to establish the next generation light wave "China Hong Kong Internet Open Exchange Point-HK Light“

- HK Light is the first Open Exchange Point in Asia

- HK Light will serve as a venue with high-speed(proposed to be 10G) networks coming from Japan, South Korea and China Taipei etc. Other States as Singapore, India and Australia are also very much interested in it.

HK Light Press Conference

Who in Korea?



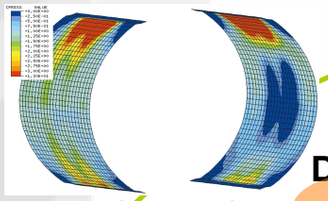
- Dr. Young-Hwa Cho, Director, Korea Institute of Science and Technology Information (KISTI)
- Dr. Jysoo Lee, Director, Supercomputing Center, KISTI
- Dr. Ok-Hwan Byeon, Dongkyun Kim, Minsun Lee, KREONet2, KISTI
- Korea Research Education Network (KREONet)

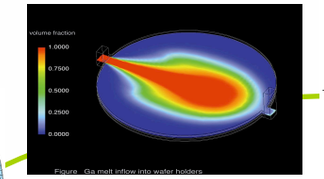
KREONET

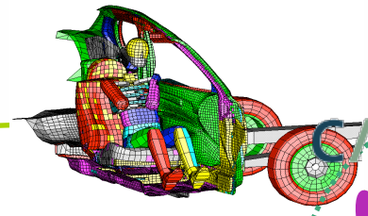
- **Korea Research Environment Open NETwork**
  - **National high-performance science & research network in Korea**
    - **About 200 members : Universities, National Research Labs, government organizations, etc.**
    - **High-capacity access network(1Gbps~10Gbps) : 30 members**
  - **Nation-wide optical gigabit backbone network**
    - **12 GigaPoPs in 11 regions (~ 10Gbps)**
  - **GLORIAD/KREONet2**
    - **International R&E network based on KREONET**
      - **Korea-US : 10Gbps**
      - **Korea-China (CSTNet/CNIC) : 10Gbps**
      - **KR-JP, KR-SG, KR-EU (via APII, TEIN) : ~2Gbps**
    - **Advanced network engineering**
      - **IPv6, QoS, Multicast, Traffic Measurement, Security, etc.**
      - **Nation-wide 6KREONET and Mbone**
    - **Supporting advanced applications : e-Science and Grid**

GLORIAD/KREONet2

Grid/e-Science based KREONET/ KREONet2/SuperSIReN
→ joining global Cyber Infrastructure
Lambda Network,-1G Access link



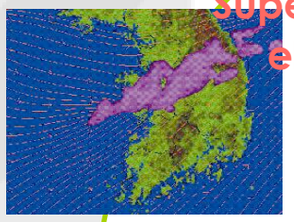


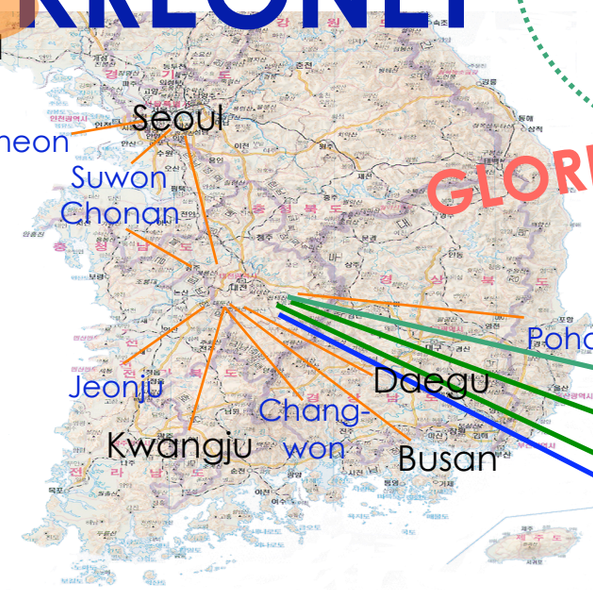


SuperSIReN

Daejeon/ KISTI

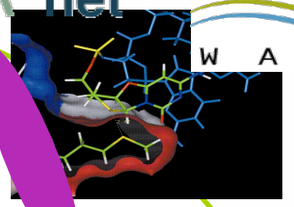
KREONET





CA*net4

PACIFIC WAVE



GLORIAD/KREONet2

STARLIGHT SM
The Optical STAR TAP™

APII

APII

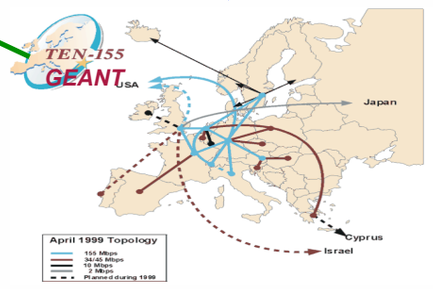
TEIN

SINET
Japan/SINET

SingAREN
Singapore/SingAREN

China/CSTNET

Europe

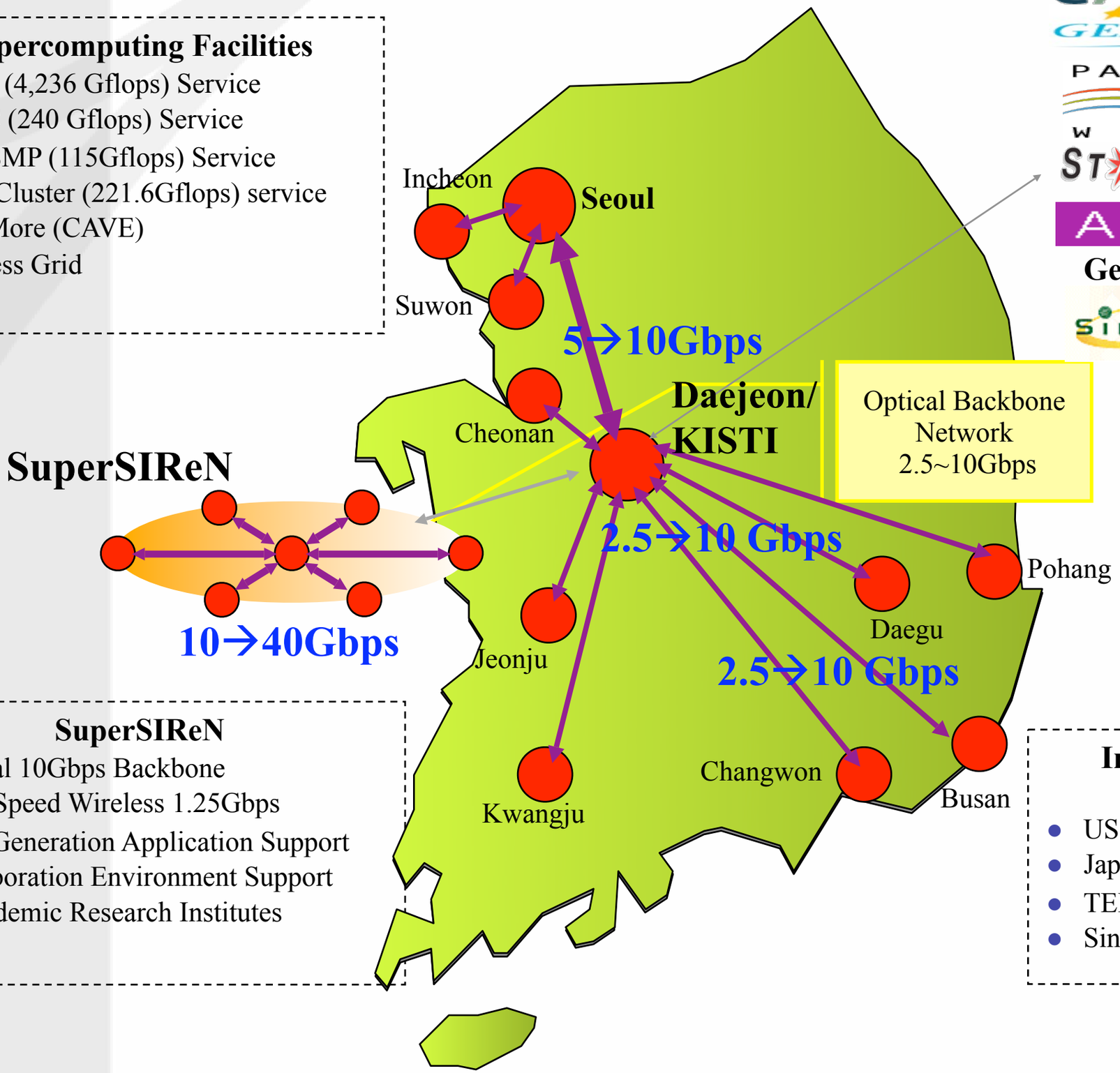


High-Performance S&T Facilities
(High-Performance Cluster/Supercomputers, Storage, Experimental Facilities, Visualization, Access Grid, DB Servers, etc.)

Backbone Networks

Supercomputing Facilities

- IBM (4,236 Gflops) Service
- NEC (240 Gflops) Service
- HP SMP (115Gflops) Service
- TeraCluster (221.6Gflops) service
- SeeMore (CAVE)
- Access Grid



CA*net4
GEANT
PACIFIC WAVE
STARLIGHT The Optical STAR TAP
Abilene
Genkai/SINET
SingAREN

KREONET

- 11 regions, 12 GigaPoPs
- 24 x 7 Operation Services
- Optical 2.5~10Gbps Backbone Network
- SONET/SDH, GigE, ATM

SuperSIReN

- Optical 10Gbps Backbone
- High Speed Wireless 1.25Gbps
- Next Generation Application Support
- Collaboration Environment Support
- 7 Academic Research Institutes

International Link(with GLORIAD-KREONet2/APII/TEIN)

- US(STAR TAP) : 1.2Gbps -> 10Gbps
- Japan (Hyunhai/Genkai) : 1Gbps
- TEIN (Geant) : 155Mbps
- Singapore (SingAREN) : 17Mbps

Who in Netherlands?

- Kees Neggers, Executive Director, SURFnet, Amsterdam, The Netherlands
- Erik-Jan Bos, Chief Network Engineer, SURFnet, Amsterdam, The Netherlands
- SURFnet, Netherlight Network
- SURFnet providing space and transit for GLORIAD and has been key contributor to architecture for GLORIAD

Who in Canada?

- Bill St. Arnaud, Senior Director, Advanced Networks, CANARIE
- Rene' Hatem, Thomas Tam, Chief network engineers, CANARIE
- CANARIE
- CANARIE Providing UCLP-enabled circuits across North America for GLORIAD and GLIF
- CANARIE Providing L1 equipment for GLORIAD and GLIF

Who in USA

Oak Ridge National Laboratory

- Greg Cole and Natasha Bulashova, Research Director/Research Scientist, UT-ORNL Joint Institute for Computational Sciences, PI/Co-PI, NSF GLORIAD Agreement
- Anita Colliate Howard (Research Assoc.), John Lankford (Network Architect/Engineer), Lyn Prowse-Bishop (Exec. Asst), 2 REU students (coming), Ana Preston, Predrag
- Sponsor: National Science Foundation (~$9.5M since 1998), Other sponsors of US-Russia work: NATO, Sun Microsystems, US State Department, Ford Foundation, Eurasia Foundation, US AID
- Many other partners: Harvey Newman (Chief Science Advisor) (~ 40 other scientists/ educators/others on advisory groups), Starlight, Pacific Wave, others
- Networks: National Lambda Rail, ESnet, NASA R&E Networks, Internet2/Abilene (peering), Federal Networks, etc.
- Also, important contributor/participant in GLIF

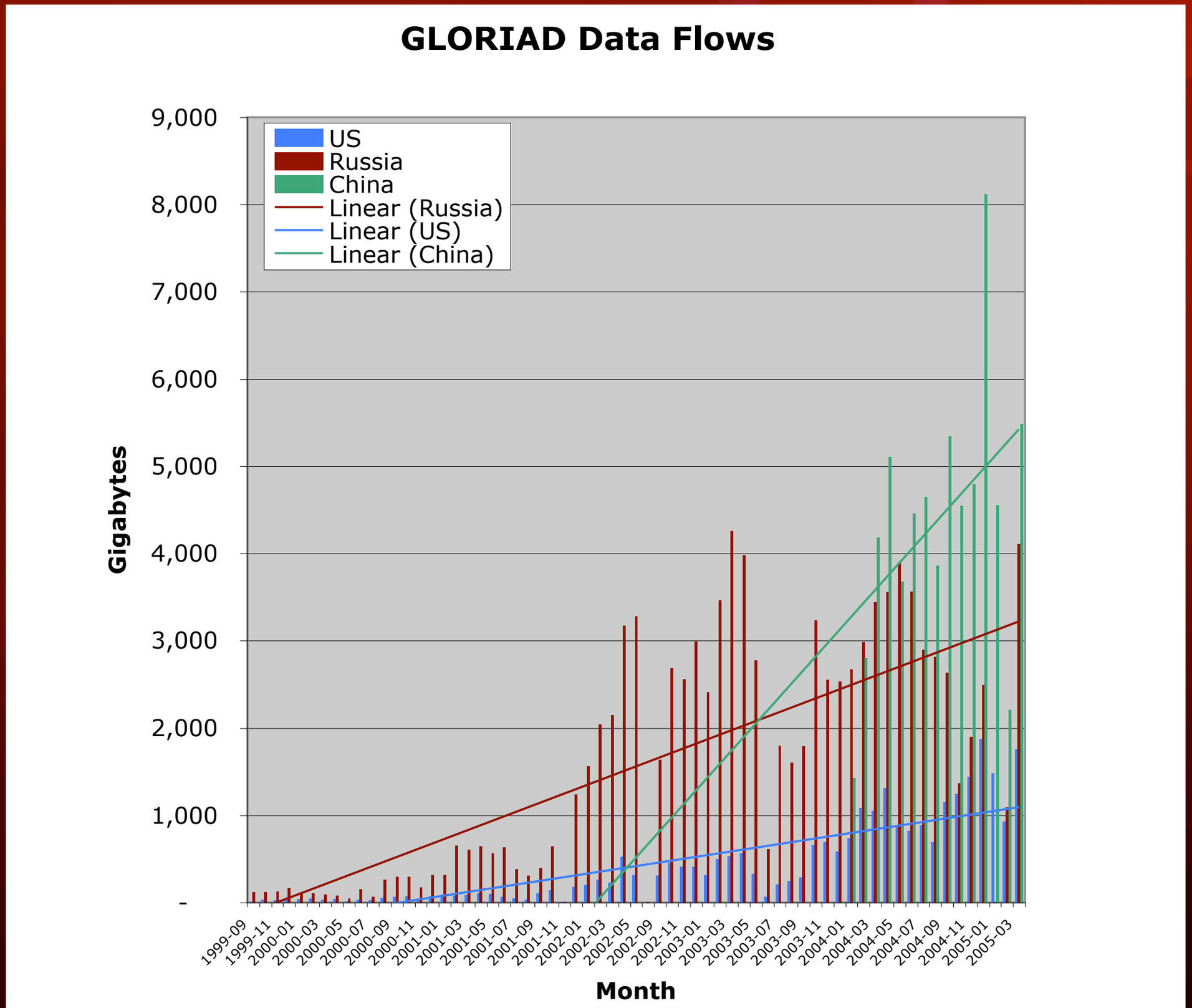
Who Ties it Together?

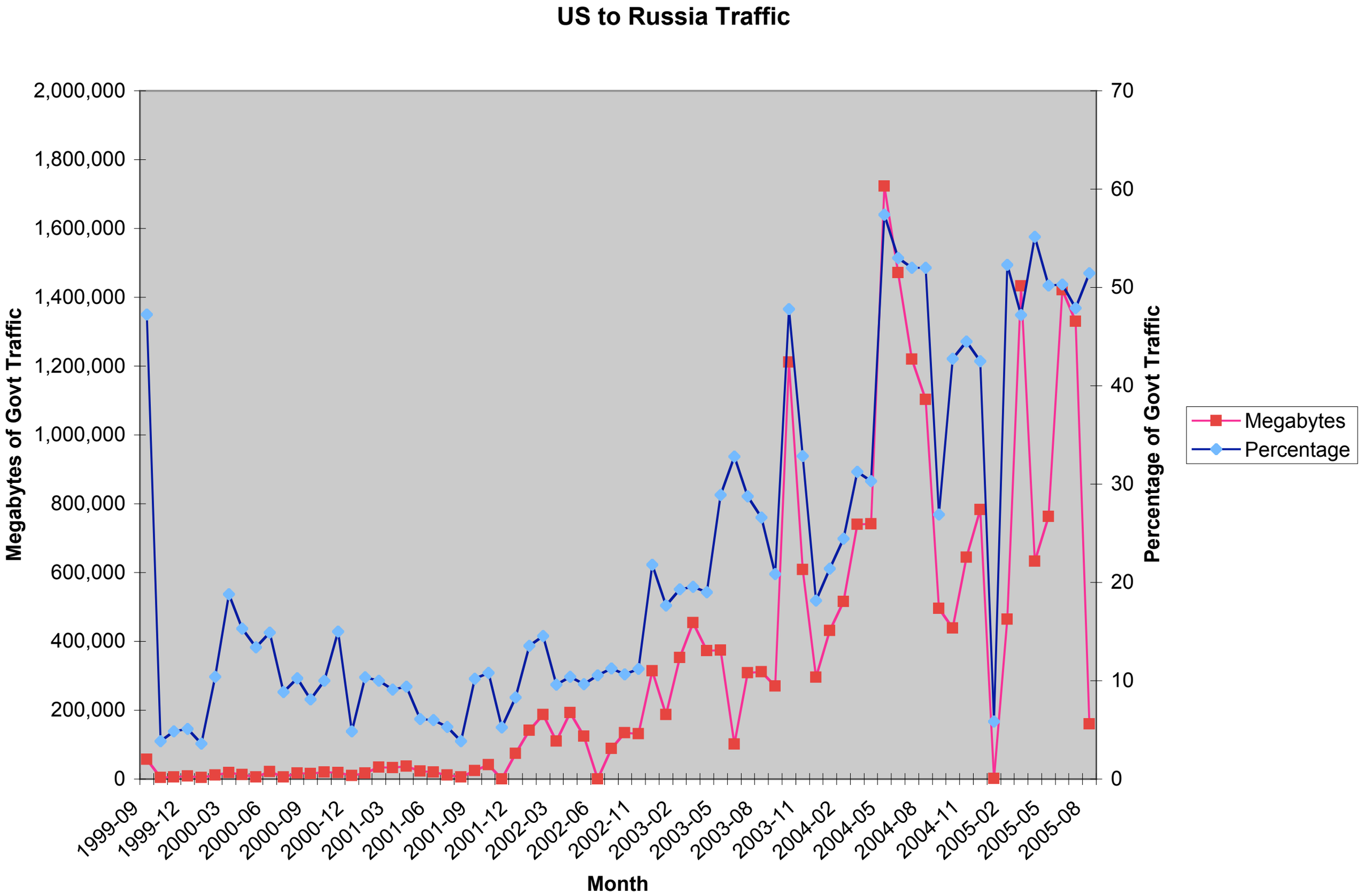
- VSNL (formerly Tyco Global Networks): Trans-Atlantic and Trans-Pacific Provider (with FLAG); is important service provider and research partner since the beginning of GLORIAD
- Russia: RosTelecomm
- China: China Netcom
- North America: CANARIE

Monitoring Program

- Utilization Monitoring (netflow-based, circuit up-time, utilization, institutional and application reporting, MonALISA)
- Performance Monitoring (Intl AMP Mesh w/NLANR)
- Security Monitoring (BRO box in Chicago for research)

Overall Traffic Growth




US to Russia Traffic
Megabytes of Govt Traffic
Percentage of Govt Traffic
2,000,000
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
70
60
50
40
30
20
10
0
1999-09
1999-12
2000-03
2000-06
2000-09
2000-12
2001-03
2001-06
2001-09
2001-12
2002-03
2002-06
2002-11
2003-02
2003-05
2003-08
2003-11
2004-02
2004-05
2004-08
2004-11
2005-02
2005-05
2005-08
Month
Megabytes
Percentage


US to China Traffic
Megabytes of Govt Traffic
Percentage of Govt Traffic
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
90
80
70
60
50
40
30
20
10
0
Megabytes
Percentage
2004-01
2004-02
2004-03
2004-04
2004-05
2004-06
2004-07
2004-08
2004-09
2004-10
2004-11
2004-12
2005-01
2005-02
2005-03
2005-04
2005-05
2005-06
2005-07
2005-08
Month

GLORIAD Top Users - Last 60 Minutes

- Home
- GLORIAD Apps
- GLORIAD Team
- Management
- Operations
- Monitoring System
- Top Users
  - Graphs-24 hours
  - Graphs-30 days
  - Graphs-90 days
  - Top Users -10 Minutes
  - Top Users -60 Minutes
  - Top Users - 3 Hours
  - Top Users - 24 Hours
- Top Applications
- Throughput
- Connection Speed
- Efficiency
- Retransmits
- Round Trip Time
- Sponsors
- GLORIAD Classroom
- Education Outreach
- Email Listservers
- Chat Room
- Search Tools

The monitoring system is designed to provide network utilization data related to usage of the GLORIAD network.

Current utilization of the GLORIAD link is illustrated below and updated every 60 minutes. The table lists the top 30 users of the GLORIAD network during the past 60 minutes.

Top GLORIAD Users
Period: **last hour** (since 2005-08-30 08:49:24 (GMT))

Source Country	Source/Machine	Destination Country	Destination/Machine	Protocol	Megabytes	% Total
United States	NASA Engin for Complex Sys (_.ecs.nasa.gov)	China	Chinese Acad of Sciences (unknown) (159.226.110._)	TCP-Other	3312.2	12.1
United States	NASA Engin for Complex Sys (_.ecs.nasa.gov)	China	Chinese Acad of Sciences (unknown) (159.226.110._)	TCP-Other	1994.9	7.3
United States	UMD (_.umiacs.umd.edu)	Russia	Moscow State Univ (213.131.1._)	TCP-FTP	1660.9	6.1
Russia	RU Space Science Internet (_.iki.rssi.ru)	Australia	edu.au (_.itd.uts.edu.au)	TCP-WWW	1379.1	5.0
United States	NASA Engin for Complex Sys (_.ecs.nasa.gov)	Russia	RU Space Science Internet (193.232.9._)	TCP-Other	1358.7	5.0
China	Chinese Acad of Sciences (unknown) (213.131.2._)	Thailand	ac.th (_.chula.ac.th)	TCP-WWW	539.7	2.0
United States	NASA Engin for Complex Sys (_.ecs.nasa.gov)	Russia	RU Space Science Internet (_.iki.rssi.ru)	TCP-Other	536.6	2.0
United States	NASA Engin for Complex Sys (_.ecs.nasa.gov)	Russia	RU Space Science Internet (_.iki.rssi.ru)	TCP-Other	454.0	1.7
China	China (unknown) (159.226.2._)	United States	Carnegie Mellon (_.ul.cs.cmu.edu)	TCP-Other	410.6	1.5
United States	UCAR (_.scd.ucar.edu)	United States	United States (unknown) (210.77.88._)	TCP-WWW	410.4	1.5
United States	US NOAA (_.cdc.noaa.gov)	Russia	sscc.ru (_.sscc.ru)	TCP-Other	405.9	1.5
Canada	Univ of Alberta	United	United States	TCP-	392.8	1.4

Slideshow of GLORIAD Launch Ceremony

A quicktime-based slideshow of the opening ceremony for the GLORIAD network is available here.

More information about the launch ceremony is available.

GLORIAD's sponsors include the US National Science Foundation, a consortium of science organizations and Ministries in Russia, the Chinese Academy of Sciences.

Telecommunications services are provided by Tyco Global Networks, Inc.

GLORIAD Top Users - Last 24 hours

- Home
- GLORIAD Apps
- GLORIAD Team
- Management
- Operations
- Monitoring System
- Top Users
  - Graphs-24 hours
  - Graphs-30 days
  - Graphs-90 days
  - Top Users -10 Minutes
  - Top Users -60 Minutes
  - Top Users - 3 Hours
  - Top Users - 24 Hours
- Top Applications
- Throughput
- Connection Speed
- Efficiency
- Retransmits
- Round Trip Time
- Sponsors
- GLORIAD Classroom
- Education Outreach
- Email Listservers
- Chat Room
- Search Tools

The monitoring system is designed to provide network utilization data related to usage of the GLORIAD network.

Current utilization of the GLORIAD link is illustrated below and updated every 10 minutes. The table lists the top 30 users of the GLORIAD network during the past 24 hours.

Top GLORIAD Users
Period: **since yesterday (1 day)** (since 2005-08-29 09:49:24 (GMT))

Source Country	Source/Machine	Destination Country	Destination/Machine	Protocol	Megabytes	% Total
United States	NASA Engin for Complex Sys (_.ecs.nasa.gov)	China	Chinese Acad of Sciences (unknown) (159.226.110._)	TCP-Other	34953.0	5.8
United States	Fermi Natl Lab (_.fnal.gov)	Russia	RU Space Science Internet (193.232.212._)	TCP-WWW	14638.1	2.4
United States	NASA Engin for Complex Sys (_.ecs.nasa.gov)	China	Chinese Acad of Sciences (unknown) (159.226.110._)	TCP-Other	12616.1	2.1
United States	NASA Engin for Complex Sys (_.ecs.nasa.gov)	Russia	RU Space Science Internet (_.iki.rssi.ru)	TCP-Other	11620.0	1.9
China	China (unknown) (159.226.2._)	United States	Carnegie Mellon (_.ul.cs.cmu.edu)	TCP-Other	9587.9	1.6
United States	UMD (_.umiacs.umd.edu)	Russia	Moscow State Univ (213.131.1._)	TCP-FTP	7378.9	1.2
United States	UCB (_.colorado.edu)	China	Chinese Acad of Sciences (unknown) (210.77.68._)	TCP-FTP	5165.2	0.9
United States	US NOAA (_.cdc.noaa.gov)	Russia	sscc.ru (_.sscc.ru)	TCP-Other	5059.1	0.8
United States	NASA Engin for Complex Sys (_.ecs.nasa.gov)	China	Chinese Acad of Sciences (unknown) (159.226.115._)	TCP-Other	5025.4	0.8

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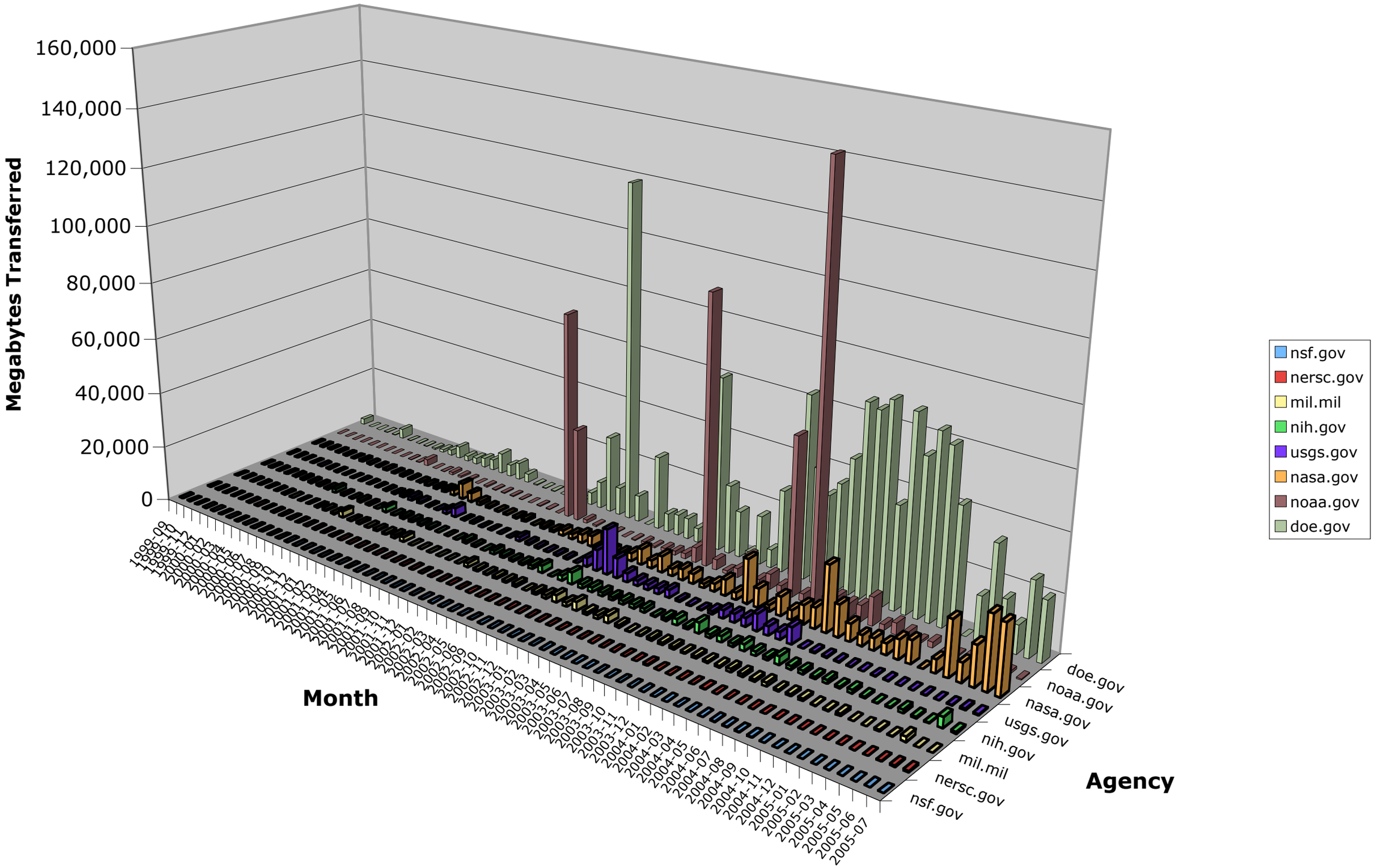
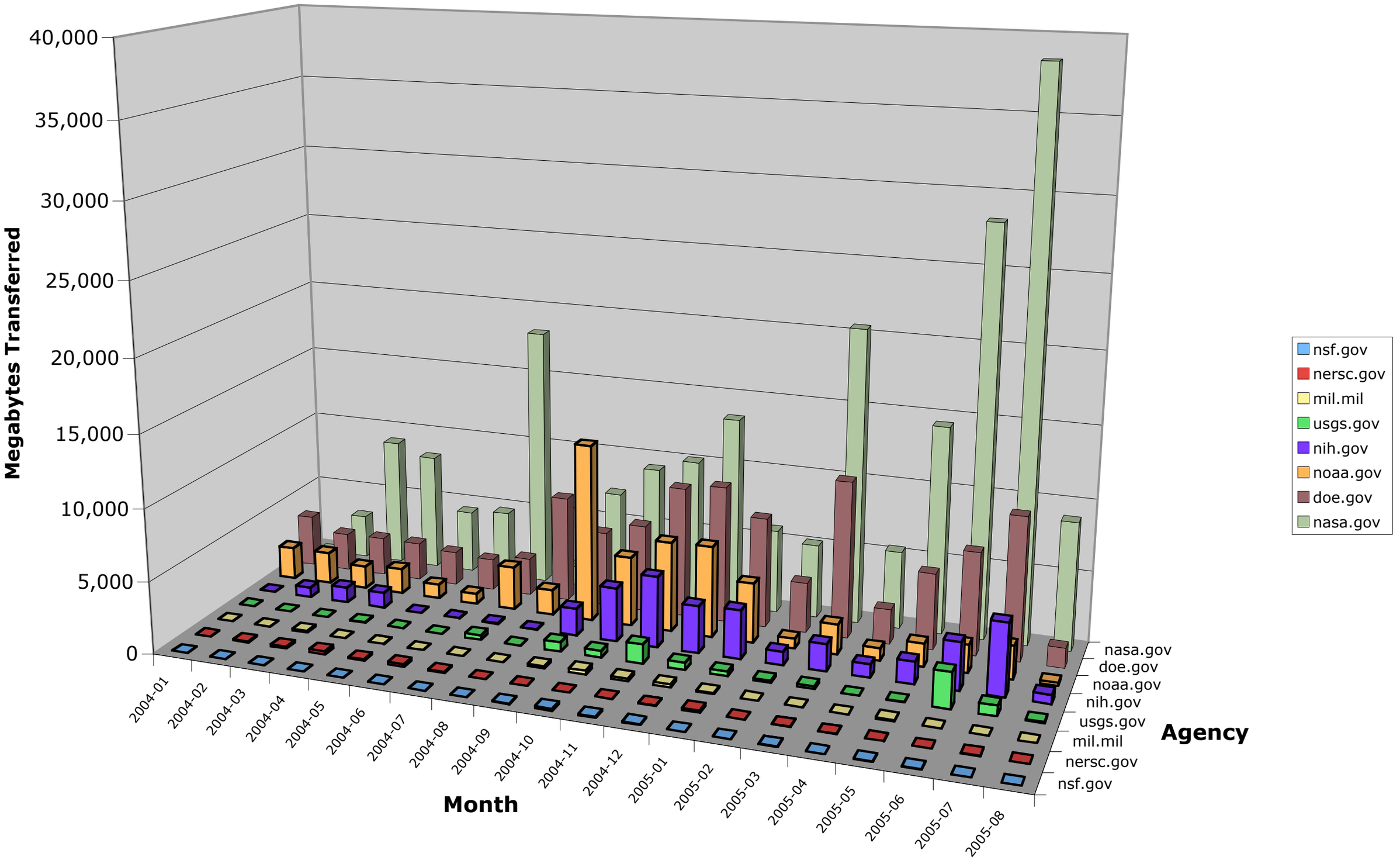
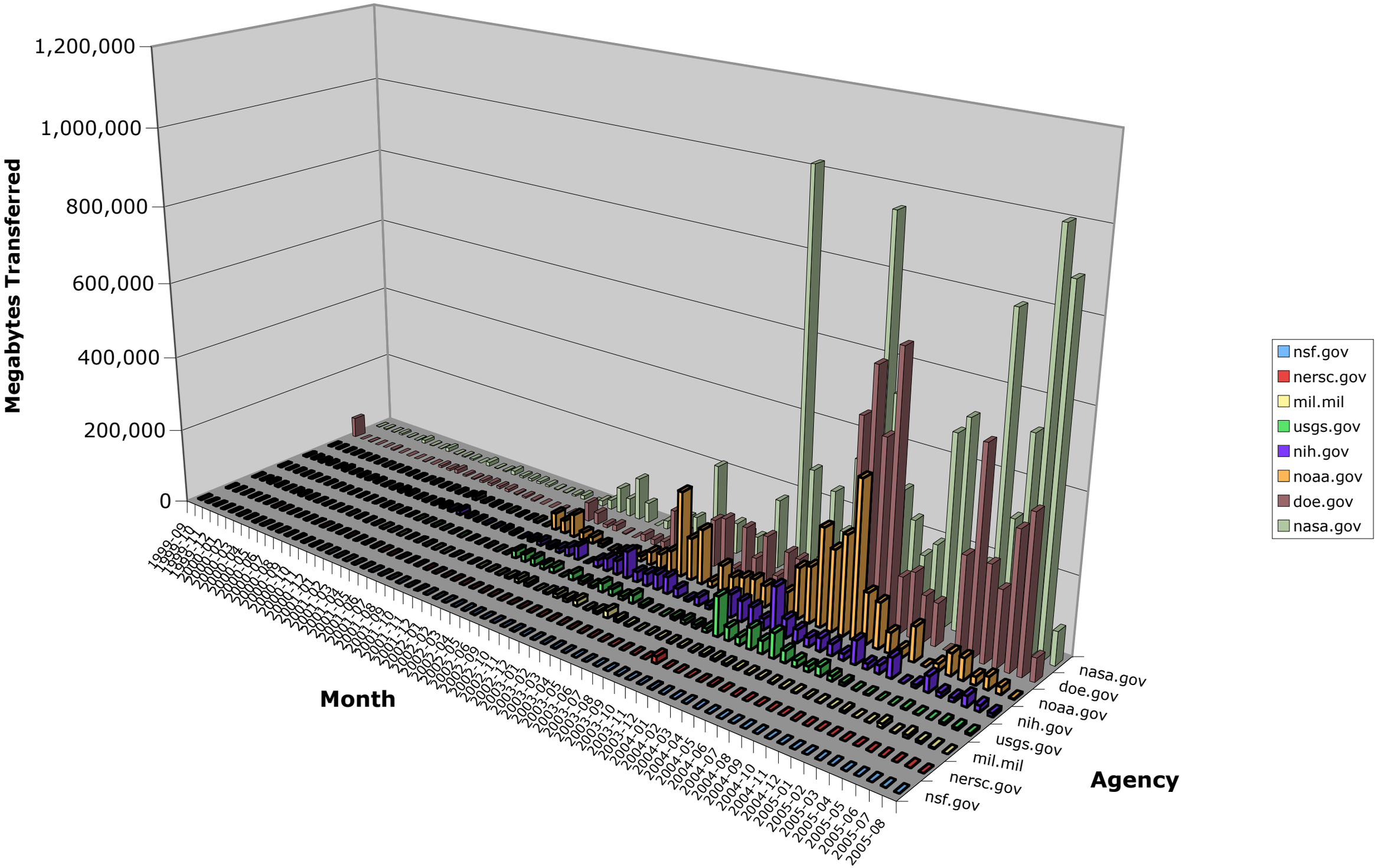
Top US Government Agencies Receiving Data from Russia



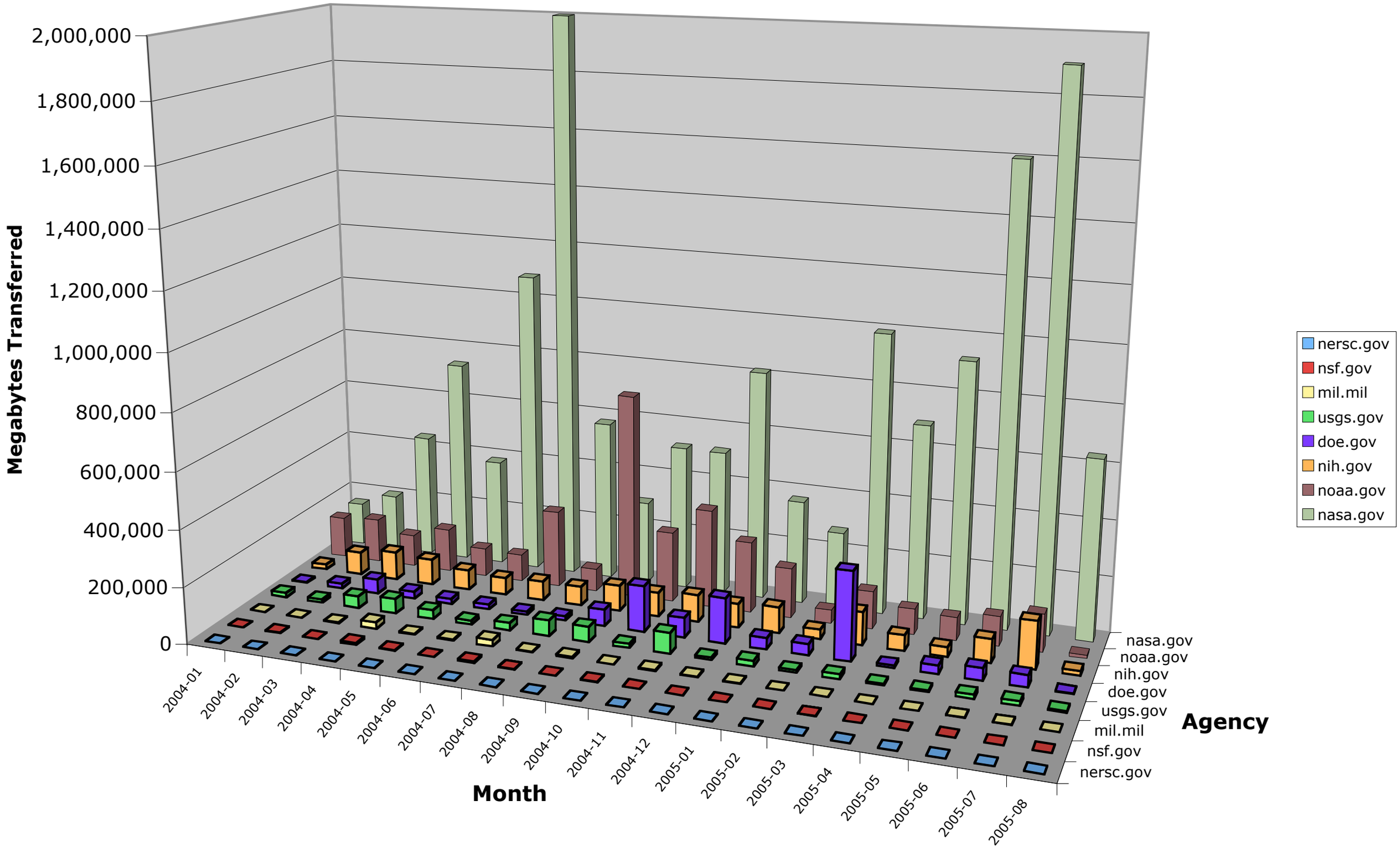
Top US Government Agencies Receiving Data from China



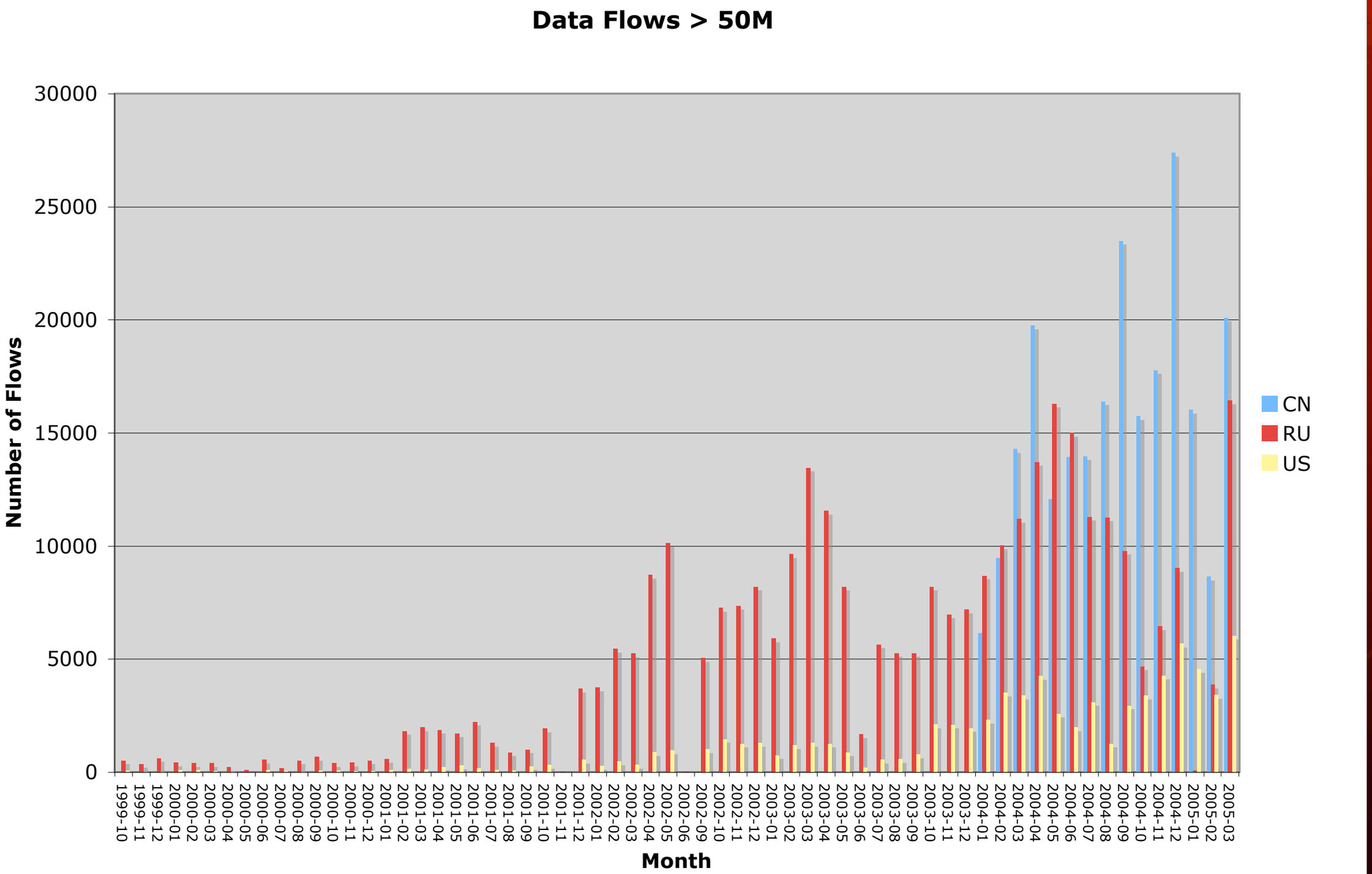
Top US Government Agencies Sending Data to Russia



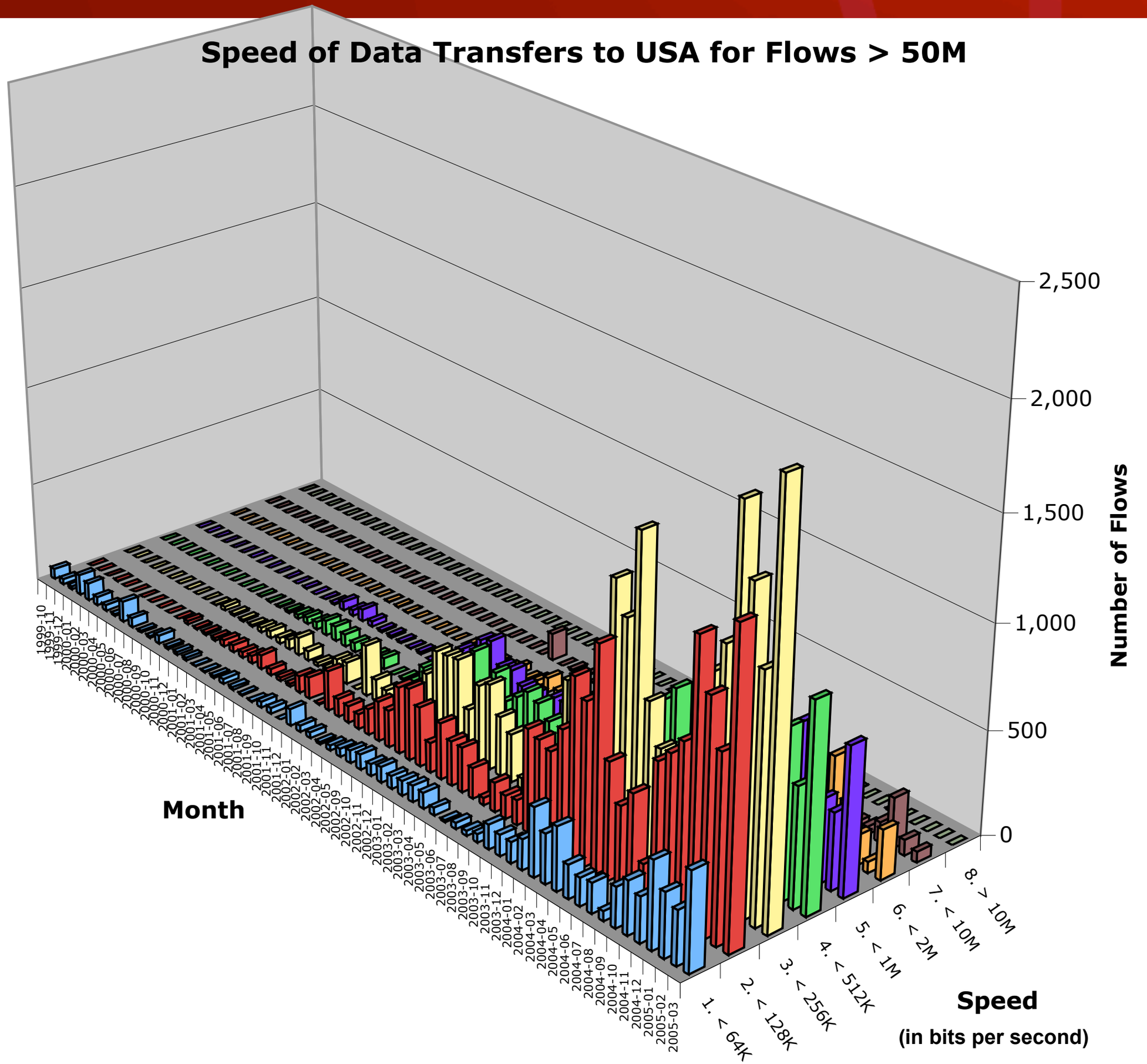
Top US Government Agencies Sending Data to China



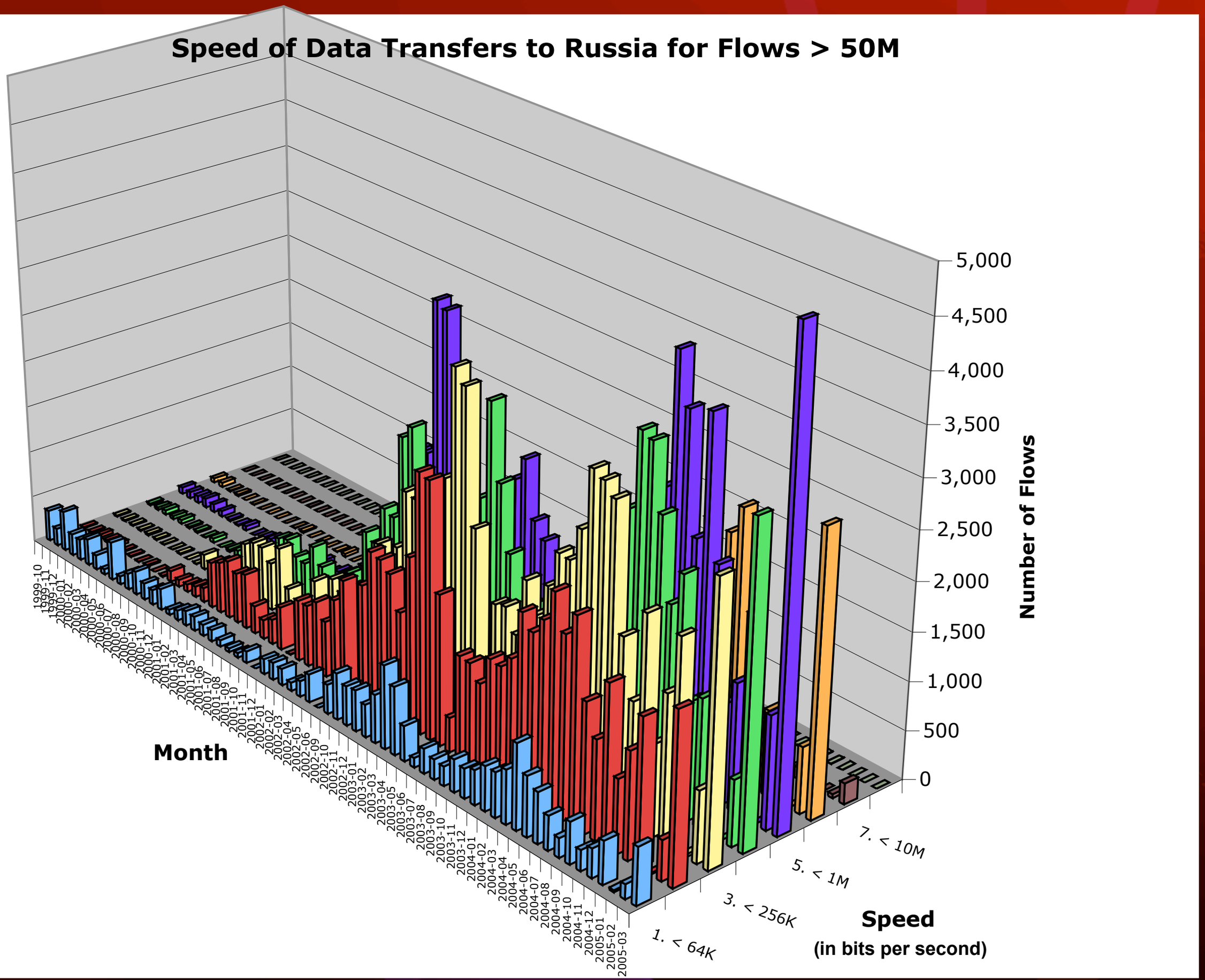
Growth in Data Flows > 50 Mbytes



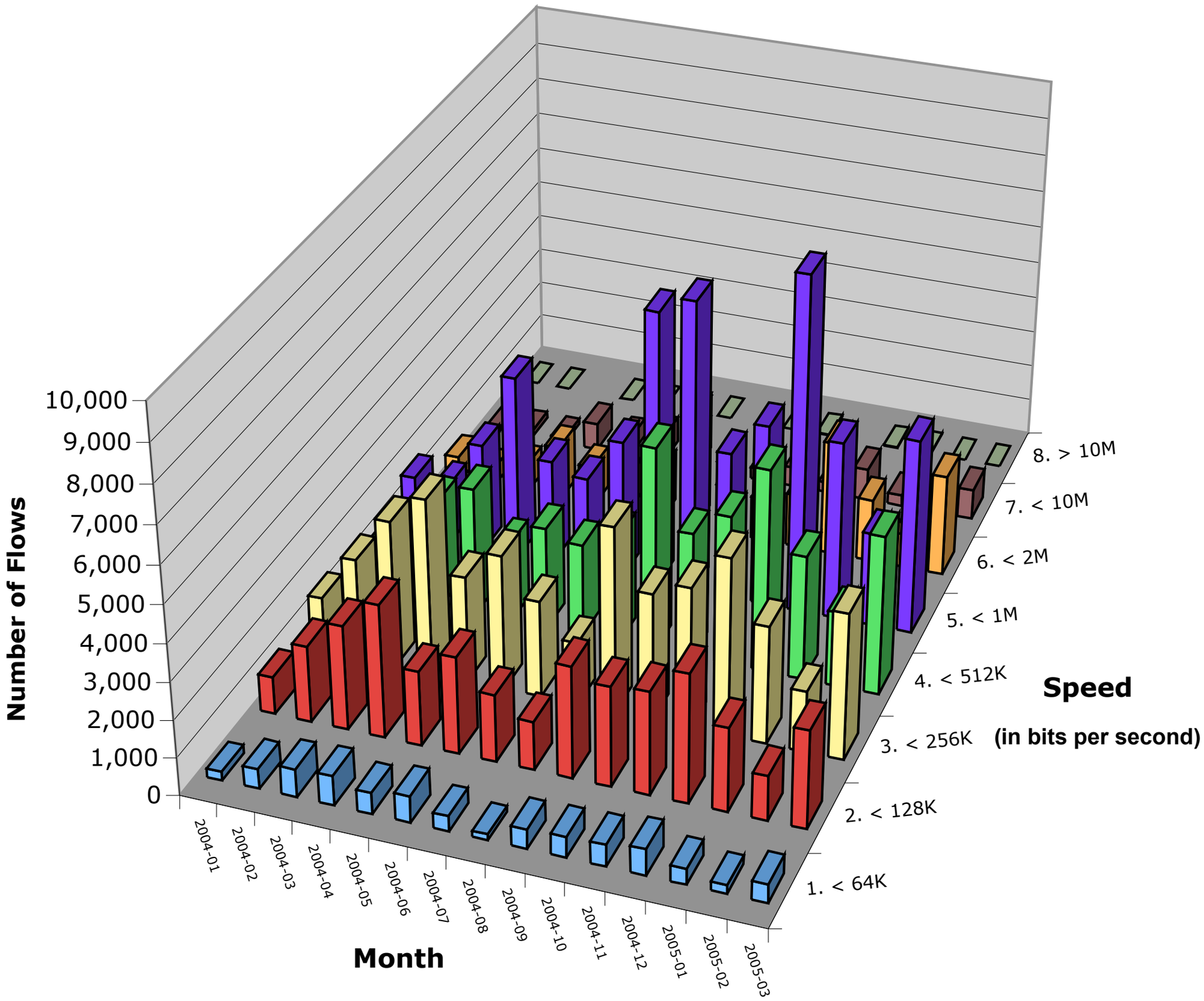
Speed of Data Transfers to USA for Flows > 50M



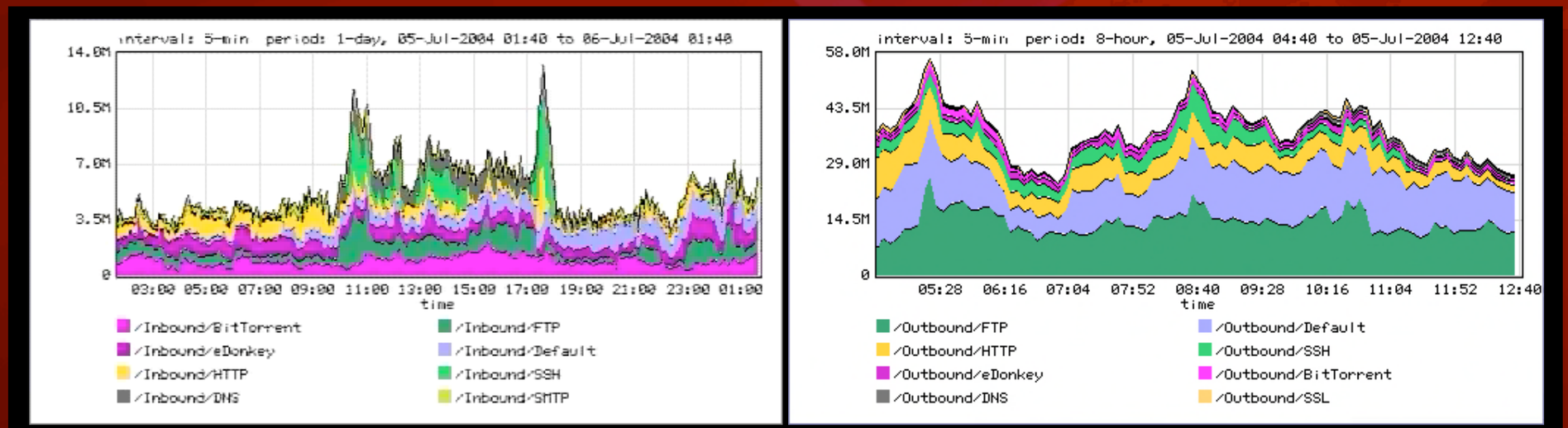
Speed of Data Transfers to Russia for Flows > 50M



Speed of Data Transfers to China for Flows > 50M



GLORIAD Application Utilization Monitoring System (using Packeteer Boxes)



- Monitoring
  - Institutional Use
  - Applications Use
  - Basic Performance metrics
  - Network “anomalies”

GLORIAD: network serving many needs

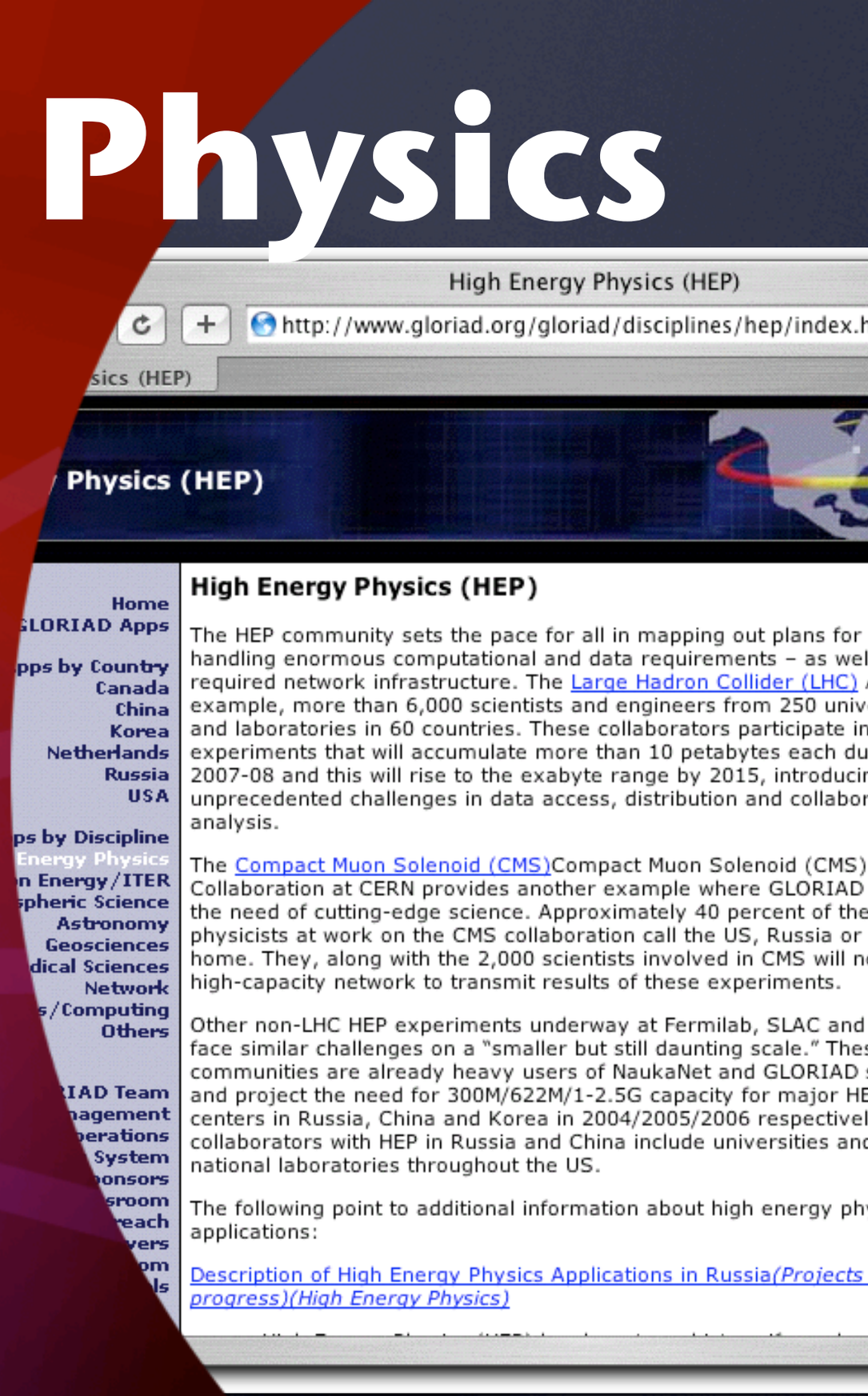
- Serving ITER, High Energy Physics, Astronomy, Atmos. Sciences, Earth Sciences, Bio Sciences, Telemedicine, Materials Sciences and many others
- Serving humanities and social sciences
- Serving Nuclear Non-Proliferation, Materials Protection, Anti-Terrorism, International Security
- Serving Educators: Edu-Cultural Digital TV Channel,Intl Science Fairs, Junior Achievement, “Simple Words”, Virtual Museums
- Serving Advanced Networking: Wavelength Disk Drive, IPv6, Collaboration Infrastructure

Driving Disciplines

- High Energy Physics
- Fusion Energy Physics/ITER
- Astronomy
- Earth Sciences
- Atmospheric Sciences/THORPEX
- GRIDS/Computational Resources
- Network Research

High Energy Physics

- Most immediate driver for international high performance S&E networking
- Large Hadron Collider (LHC) experiments will begin generating petabytes of data in 2007-2008, exabytes by 2015
- Community has developed international infrastructure for sharing data for shared analysis
- Heaviest single community user of GLORIAD today (40% of traffic some days)
- Propose need for GbEs immediately



Fusion Energy

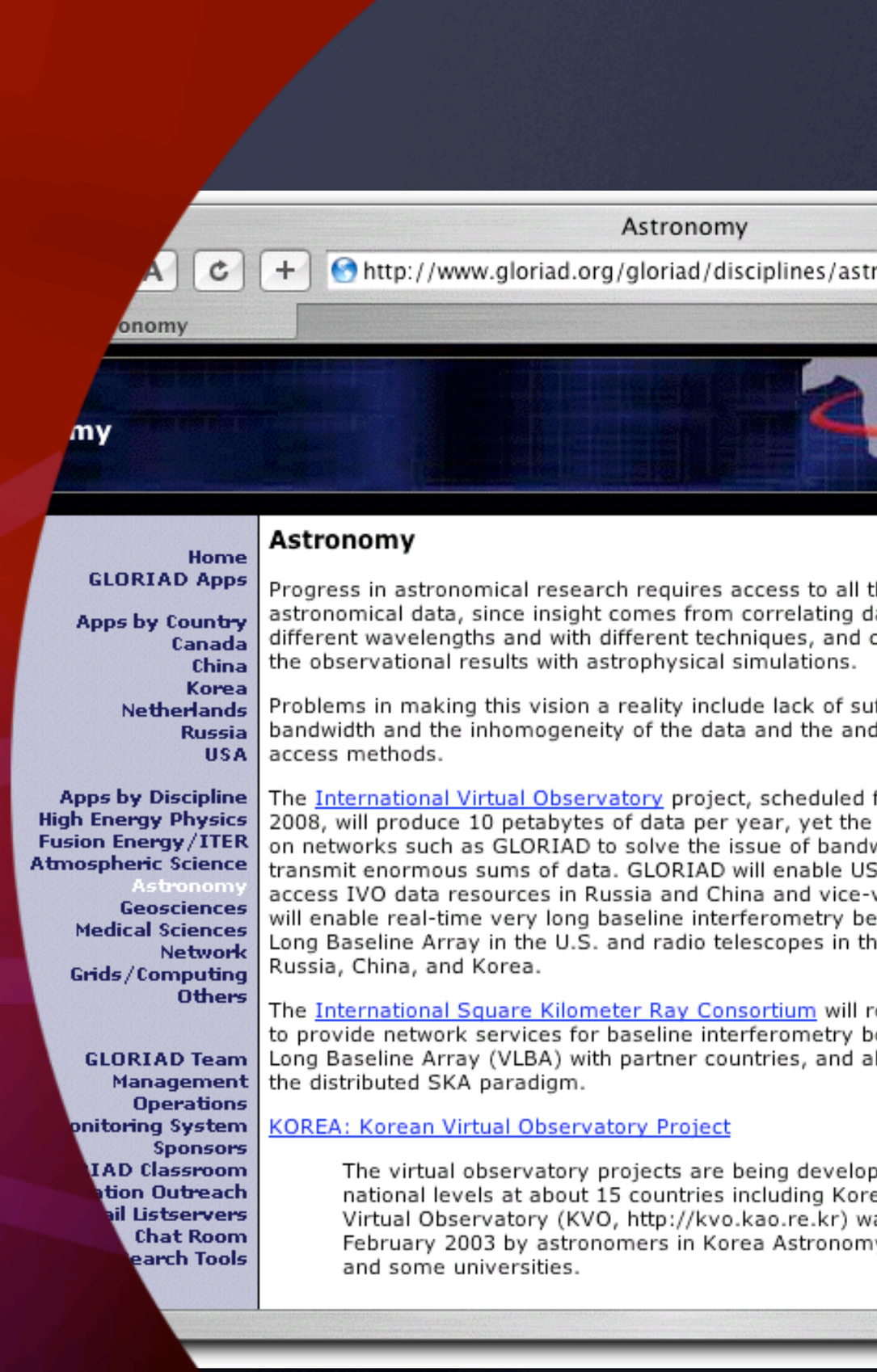
International Thermonuclear Experimental Reactor

- GLORIAD motivated, in part, to help serve ITER community (US, Russia, China, Korea, Europe, Japan)
- $Multi-billion construction to begin soon (site decision is made); #1 science/facility priority for US Department of Energy
- Will require GbE around GLORIAD ring initially; 10G circuit by 2008
- Heavy user of computational resources, need to cooperatively control experiments remotely, massive data storage and transmission requirements

GLORIAD/ITER-Grid Meeting, December 21, 2003

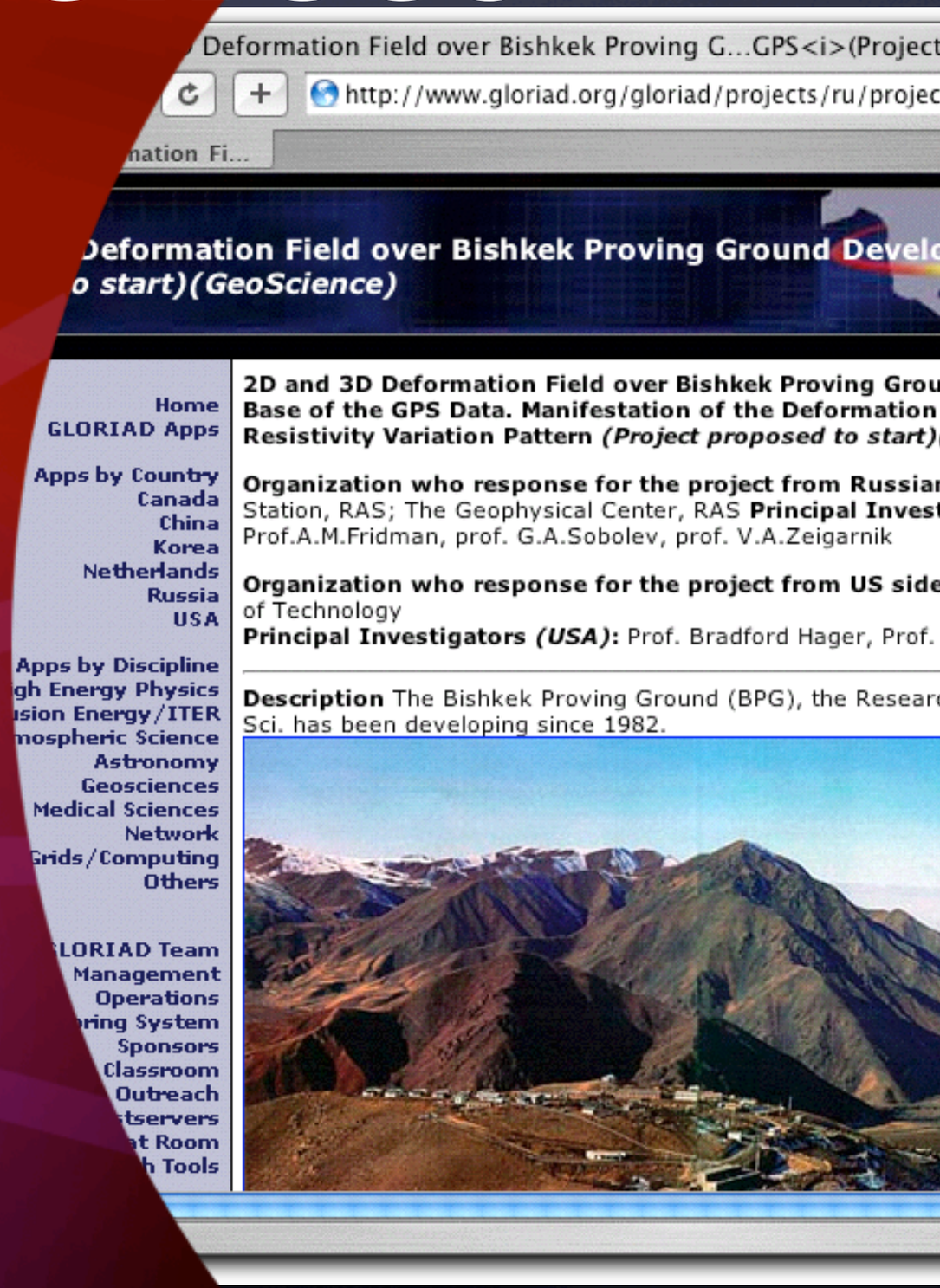
Astronomy

- International Virtual Observatory Project (involving US, Russia, China, Korea, Europe, others) proposes generation of 10 petabytes of data annually
- International Very Long Baseline Interferometry (VLBI) involves very high capacity network access to radio telescopes in Netherlands, US, Russia, China, Australia, elsewhere; network access to require multiple DWDM wavelengths



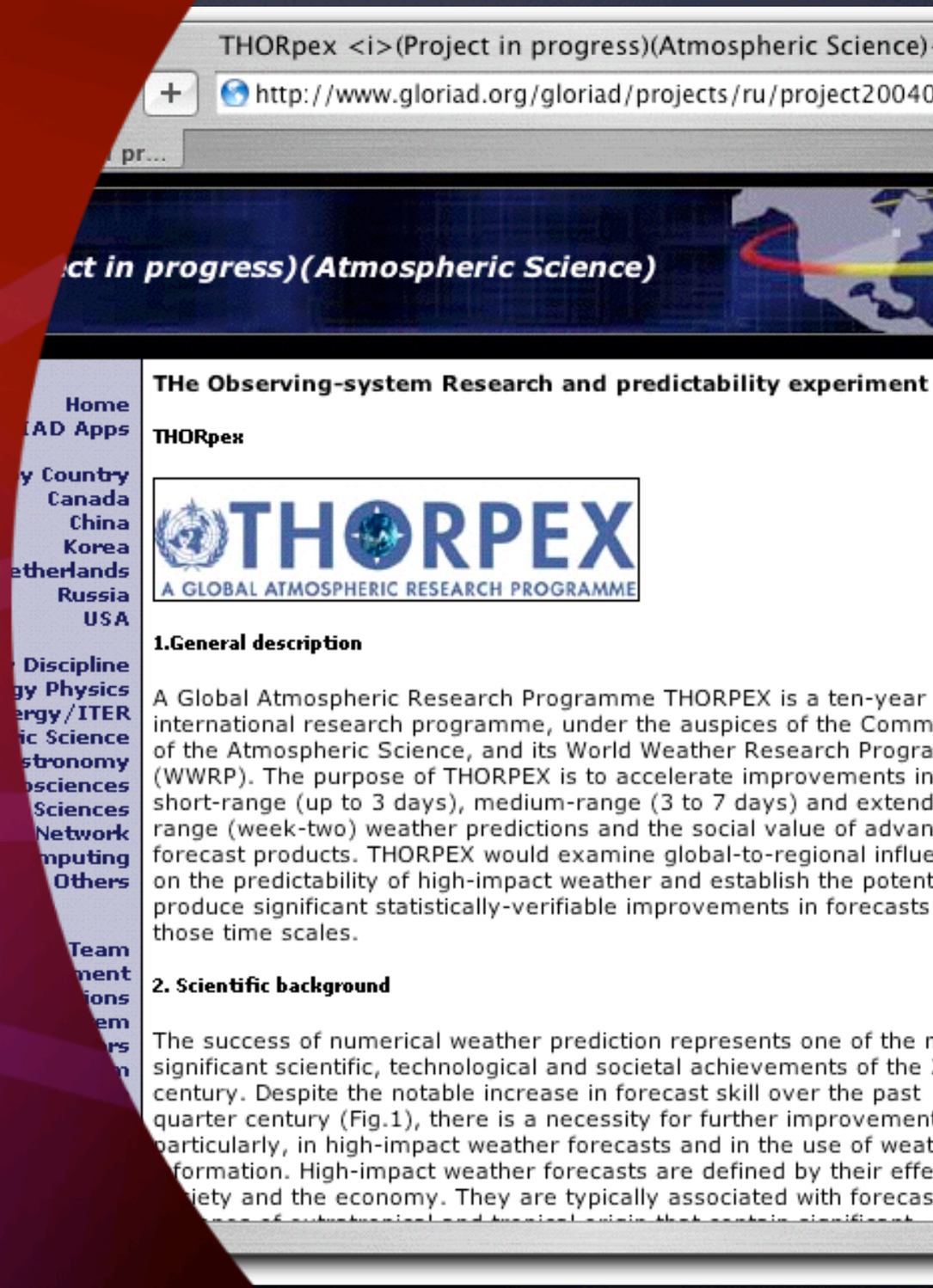
Earth Sciences

- US, Russia, China, Canada together comprise large percentage of earth's surface and already have large domestic infrastructure for sensing seismic activity, atmospheric conditions, environmental conditions, satellite-based imagery coverage, etc.
- GLORIAD proposes to ensure higher capacity/easier data sharing between major earth science initiatives – seismic monitoring, satellite imagery, environmental monitoring, forestry/wildfire studies, etc.
- Special emphasis in GLORIAD on extending access to Central Asia generally and to the Bishkek Geologic Proving Ground specifically



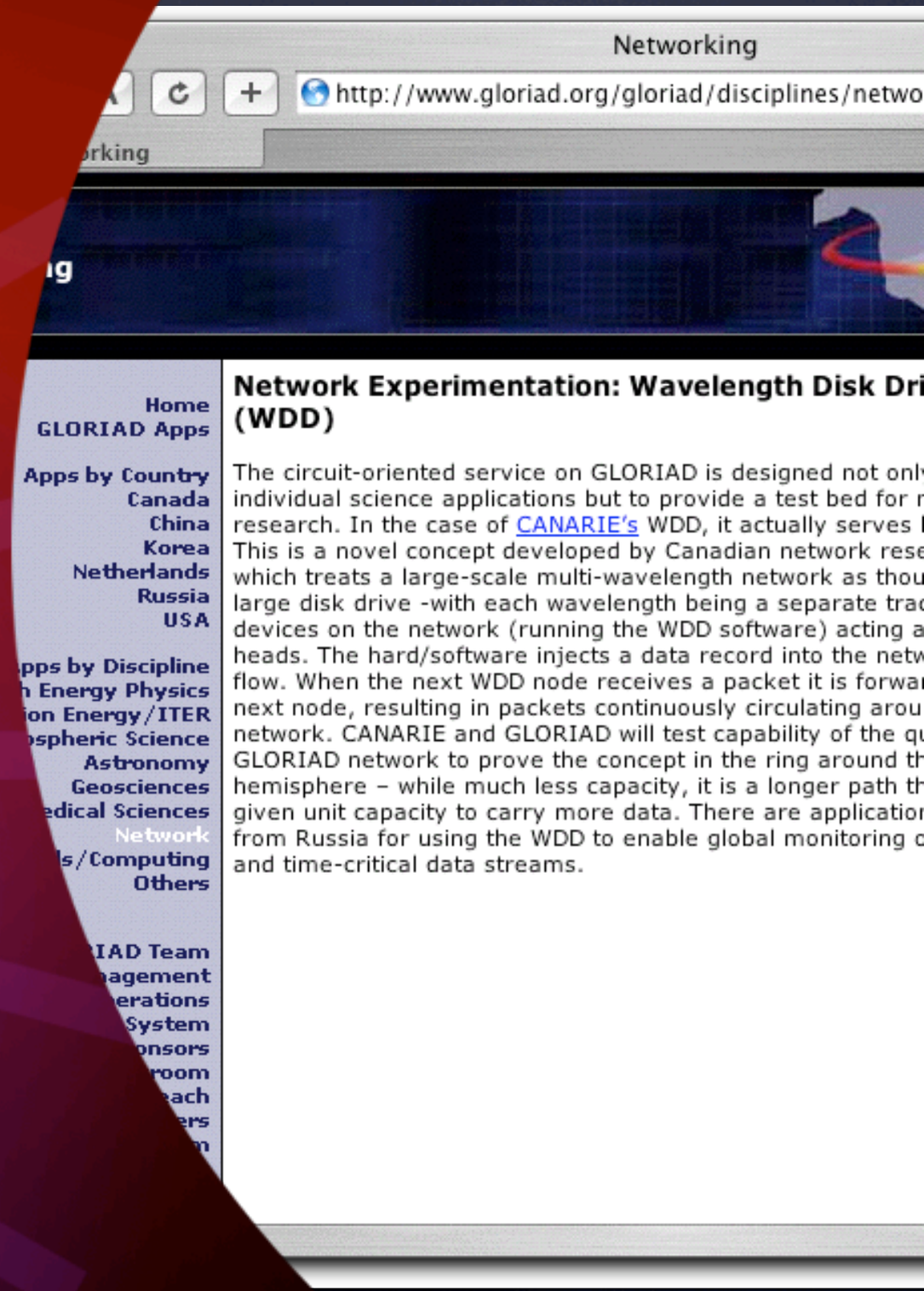
Atmospheric Sciences

- Programs include general atmospheric modeling, climate change studies, weather prediction, etc.
- Data transmission requirements requiring GbE+ (also enormous shared computational and data storage)
- Special emphasis on International THORPEX program – established in 2003 as a 10-year global atmospheric R&D program – emphasis on mitigating effects of natural weather-related phenomena by providing much more accurate 1-14 day forecasts.



Network Research

- With its hybrid architecture, GLORIAD will provide an experimental “sandbox” for network researchers – enabling experimentation without putting production services at risk
- One proposed project is the Canadian Wavelength Disk Drive (WDD) – treating a service across the GLORIAD ring as a “disk drive” – circulating data around the earth with “readers” and “writers” at various locations – useful for data needed by international parties at approximately the same time
- Another is the Canadian User Controlled Lightpath (UCLP)



Other Areas of Collaboration

- Grids and Shared use of Computational Resources
- Network Security
- Materials Science (ORNL's SNS)
- Bioinformatics/Bioengineering
- Telemedicine (US-Russia effort in cancer research)
- Nuclear Materials Protection and Non-proliferation programs
- Emergency Response
- Joint Anti-terrorism Programs

Education & Outreach

- Central Asian and Western Eurasian networking extension
- Big Interest re: connectivity to India and Pakistan
- GLORIAD Classroom
- EduCultural Channel
- Collaboration Infrastructure (IP Telephony Network (using Cisco donation) and HEP/VRVS)
- "Simple Words" Essay Program
- "Junior Achievement" Partnership
- Virtual Science Museum of China
- "Great Wall" Society Programs
- Electronic Cultural Atlas Initiative

Year 1 Plans

- Grand Opening Ceremony, New Operating Agreement
- Complete Architectural Plans, Landing Sites/Equipment Deployment, New Circuits (Amsterdam, Moscow, Hong Kong, Busan)
- Governance Structure, Working Groups Operational
- GLORIAD Classroom
- EduCultural Channel
- Collaboration Infrastructure Deployed (IP Telephony, VRVS Reflectors)
- BRO Box deployed, integrated with router
- New Monitoring System (using Packeteer/Netflow product)
- New Web Site
- “Simple Words” Pilot in US

This is all made possible by …

- NSF (6+ years of support) and our sponsors in Russia, China, Korea (and others)
- Our partners in Russia, China, Korea, Netherlands, Canada, throughout the GLIF
- US partners - UT/ORNL (Homer Fisher, Bill Snyder), NCSA, UT/ORNL (again), Jim Olson, Mike Rieger, Bill Marra (Tyco), Starlight partners: Tom, Joe, Maxine; IRNC partners, Harvey Newman, Steve Goldstein, Tom Greene, Aubrey Bush, Yves Poppes, partners at US govt agencies (and many, many others)
- Email, the Internet, Trans-oceanic/contintental circuits, “Friends and Partners”

Global Ring Network for Advanced Applications Development (GLORIAD)

ONT2 Workshop
September 13, 2005

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Animation by Chinese Academy of Sciences
Computer Network Information Center

http://www.gloriad.org/

VSNL